# CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

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# THE VERTEBRATE ANIMALS OF FRIANT RESERVOIR BASIN WITH SPECIAL REFERENCE TO THE POSSIBLE EFFECTS UPON THEM OF THE FRIANT DAM [1]

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## INTRODUCTION

Friant, California, is located at the base of the Sierra Nevada foothills, 20 miles northwest of Fresno on the San Joaquin River. Once a sleepy town with a filling station and general store, it has become a small city since the Bureau of Reclamation, United States Department of the Interior, began the construction of Friant Dam, a large unit in the Central Valley Water Project. This dam, located one-half mile above the town, will block the San Joaquin River and cause flooding of a large basinlike area behind the dam. The reservoir thus formed will be of an unusual shape. Approximately two and one-half miles in width behind the dam, it narrows continuously, as does the canyon cut by the San Joaquin, until a minimum width of about a hundred feet is reached at a point approximately 15 miles behind the dam and less than one mile below Kerckhoff Dam and powerhouse. The elevation at the top of the dam will be 600 feet above sea level; the maximum water level, 578 feet. At the time of writing, construction is well under way and, if work continues at its present rate, will be finished and flooding will take place by the fall of 1941. Unlike storage lakes, reservoirs vary in depth according to the amount of water drawn out for irrigation purposes and the amount of rainfall. The water level in Friant Reservoir will be subject to a variation of 143 feet.

When the dam is completed, a country rich in early California history will be flooded. Old Fort Millerton, located on the Richard McKenzie property, and now the headquarters of the Charles Green Ranch, was constructed while California was under military rule between 1854 and 1856 to guard the large numbers of miners in the area against raids from the Yokut Indians who were at that time numerous and troublesome in the area. The buildings of the old fort settlement are located less than 200 yards from the river, about two miles air-line north of Friant. When the reservoir is filled to its maximum, they will be almost 200 feet under water. The site of Millerton, the original county seat of Fresno County, located on the banks of the San Joaquin about one mile below the fort, will also be submerged.

[1] Submitted for publication, March 14, 1941.

This thriving frontier settlement was abandoned and most of the houses torn down and moved to the present site of Fresno with the coming of the Southern Pacific Railroad, which crossed the plains through the area where the City of Fresno is now located. The old Millerton courthouse, a magnificent brick and granite structure in its day, is still standing but in ill repair and severely damaged by vandals. The heavy iron shutters, typical of early California buildings, and the granite jail, with its dungeons and iron-barred windows—once the finest and strongest jail in the West—may still be seen. Of the remainder of the town, stone foundations are all that remain.

### Acknowledgments

The writer is indebted to Mr. R. B. Williams, Construction Engineer of the Friant Dam, and to Messrs. A. A. Whitmore, G. A. Hogue and Marshall Young of the United States Bureau of Reclamation, for supplying maps and valuable information regarding the Friant Project. To the late Charles Green, Sr., and Mrs. Green, thanks are due for allowing the writer to have the freedom of their ranch on many occasions and for innumerable small courtesies during his stays there. To his cousin, Mr. Richard H. Boyer, without whose help this study would not have been possible, grateful thanks are due. To Dr. E. Raymond Hall, Curator of Mammals of the University of California Museum of Vertebrate Zoology, for supplying traps and materials, and to Dr. Richard M. Eakin, University of California Department of Zoology, his undergraduate advisor, and to Dr. Wm. T. Shaw, Professor of Zoology, Fresno State College, whose interest and encouragement have been most helpful, appreciation is generously acknowledged.

## THE STUDY

The writer became interested in the Friant Reservoir area while a student at Fresno State College. In 1937, three field trips were made into the region, and in the summer of 1940 three weeks were spent in the field.

Several years of full time study could easily be spent in the Friant Basin, and many questions regarding the animal life of the area would still remain unanswered. For this reason it was decided to take a trap strip 200 yards wide, extending from the present river level to the maximum level of the water in the future reservoir, and concentrate on the vertebrates found on it. The strip chosen was located three-eighths of a mile north of Old Fort Millerton, and contained willow, rock, grassland, oak and chaparral habitats. (See Fig. 54.)

The topography of the entire basin is typical of the Sierra Nevada foothills, as may be seen from the illustrations. It is characteristically grassland, with oaks of several species and digger pines being the principal trees. Granite outcroppings are frequent. Two large basalt "caps" or "table mountains" are visible from the bottom of the basin. One of these, Pincushion Mountain, rises to 1,593 feet above sea level. This mountain, when the reservoir is filled, will be a portion of a large peninsula. The other table mountain (Fig. 55) is 1,500 feet in elevation and has been considered as a site for an airport for the City of Fresno, where at certain seasons of the year "tule" fogs make airplane landings hazardous.

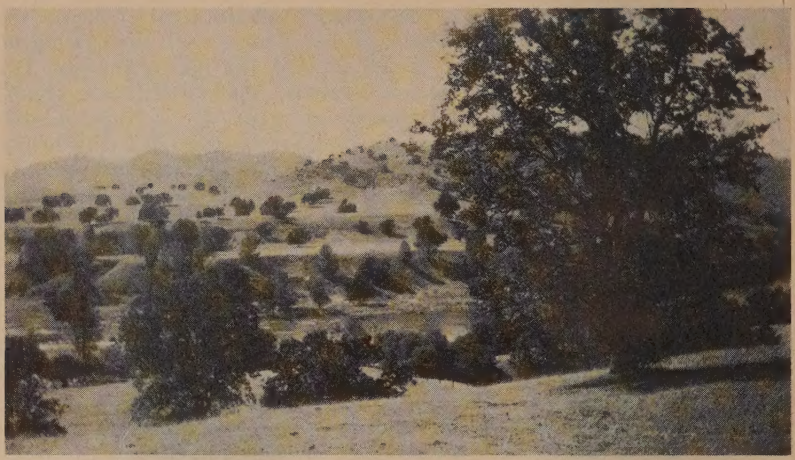

FIG. 54. Looking across the San Joaquin River from the second plateau on the Fresno County side of trap strip. Fence in middle foreground marks north boundary of this strip. Blue oak (*Quercus douglasii*) in foreground.

The topography of the trap strip selected is similar on both sides of the river. On the Fresno County side a sandy beach rises above the river; this extends for 20 yards, where it gives way to an area of water-worn granite. This granite area about 35 yards wide is bounded by a steep bank of dirt and water-smoothed pebbles of varying diameter which rises about 50 feet to the first plateau—a level, dirt plain about 100 yards wide (see Fig. 57). This is followed by another slope, oak-covered and leading to the second plateau, about 250 yards in

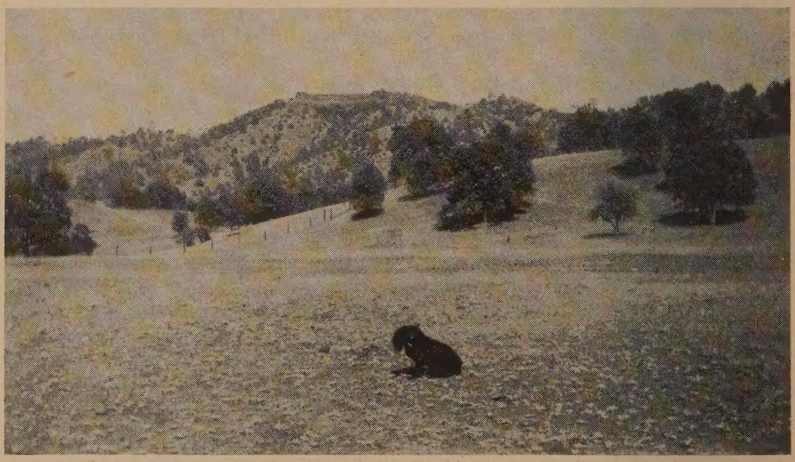

FIG. 55. Looking east across the first plateau from the south boundary of trap strip toward Table Mountain. Fence (middle, left) marks north boundary of trap strip. Photograph shows abundance of turkey mullein (*Eremocarpus setigerus*), an excellent food for mourning doves.

width, which runs to the final incline leading to the future reservoir shore, about 150 (horizontal) yards beyond the end of the second plateau. The Madera County side is almost identical except that instead of having a sandy beach and a gradual slope up to the level of the first plateau, the incline is steep and formed of dirt and water-rounded pebbles—the result of placer mining in the days following the gold rush.

A variety of trees and shrubs is found on the Fresno County side of the river. The dominant tree of the sandy, riparian habitat of the shores of the San Joaquin is the black willow (*Salix nigra* Marsh var. *vallicola* Dudley). (See Fig. 56.) These trees are present in large numbers, usually close enough to the river to permit their roots to run out into the water. When the river level drops, solid mats of willow roots are exposed on the banks. In the water and on sand bars the sand-bar willow (*Salix sessilifolia* Nutt. var. *hindsiana* And.), readily

FIG. 56. View up San Joaquin River from beside camp. Sand-bar willows (*Salix sessilifolia*) in foreground, black willow behind rock on right. Yellow pine shown at extreme right. "X" in middle marks approximate future water level.

recognized by its silvery color, is present. Of the other trees in the area, especially on the trap strip, the blue oak (*Quercus douglasii* H. & A.), the interior live oak (*Quercus wislizenii* A. DC.) and the digger pine (*Pinus sabiniana* Dougl.) are about equally common. The valley oak (*Quercus lobata* Nee) while fairly abundant is less numerous than these others. Creek senecio (*Senecio douglasii* DC.) is present in an old diversion channel. The sandy bottom of this channel is covered with a thick mat of Bermuda grass (*Cynodon dactylon* (L.) Pers.), supposedly a native of the Old World. Another non-native plant found in abundance is the tree or "Chinee" tobacco (*Nicotiana glauca* Graham). When in bloom it is a favorite food of humming birds, both the Anna and the black-chinned varieties having been seen feeding on it in the vicinity. In the willow habitat, jimson weed (*Datura stramonium* L.) is common. On the granite above the sandy shore, bush lupines (*Lupinus* sp.) are present in large numbers.

Unfortunately they were not in bloom, and could not be identified to species. From the edge of the rocky, old river bed, there is an occasional oak and bush lupine on the slope leading to the first plateau, but grasses predominate. Of these, *Bromus rigidis* Roth is the most common. This grass is harmful to animals, as the sharp, disjointed florets enter the eyes, nose and feet and have been known to cause blindness. Another grass found in many places, especially growing out of dirt-filled cracks in rocks, is the slender oat (*Avena barbata* Brot.). On top of the first plateau, one is at once impressed by the abundance of turkey mullein (*Eremocarpus setigerus* Benth). (See Fig. 55.) The plants are small, averaging about one inch in height, but their great numbers make up for what they lack in size. The presence of this plant makes this area a favorite one for mourning doves, as turkey mullein is one of their most important food plants. On the second plateau brome is the dominant ground cover. As one goes beyond the plateaus, and climbs the slope leading to the future reservoir shore, there is a marked change in the flora. Brome is the principal ground cover, but turkey mullein is no longer seen. Oaks become fewer, and digger pines more numerous. A new plant—typical of the chaparral habitat—buckbrush (*Ceanothus cuneatus* (Hook) Nutt.) appears in considerable quantity and is found to the top of the range which forms the Friant Basin. In addition to the plants described, there are many annuals, especially wild flowers, which dry up and disappear by early summer.

On the Madera County side the floral picture is entirely different. The shore of the trap strip opposite our camp is devoid of vegetation close to the water, although willows are found farther up the river. About 50 feet from shore, there is a strip of willows growing in the water. Several explanations may be suggested for this absence of willows—perhaps none is correct: It may be purely a coincidence that none has taken root in this particular place. Perhaps the river, which swings toward the Fresno side at this point, has failed to deposit seeds on the Madera shore. Possibly the large-scale hydraulic mining on the Madera side robbed the soil of materials essential for plant growth. The picture, at any rate, is this: Instead of a shore densely covered with willows, Bermuda grass, senecio, jimson weeds, and other plants found on the Fresno side, the shore is covered with water-worn pebbles of various sizes. In the area between the river and the first plateau, a slope of about 100 feet vertically and 150 feet horizontally, may be found only three interior live oaks, two valley oaks and 14 digger pines. On the first plateau, digger pines are dominant. A few live and blue oaks may be seen. The slope that rises from the first up to the second plateau has only a ground cover, no large trees being present. Beyond this, on the second plateau, a few blue oaks are growing. The rise between the first and second plateaus on the Fresno side is evenly spaced for its entire height with live and blue oaks. As mentioned earlier, the final slope to the future water level, on the Fresno side, is vegetated with digger pines, oaks and buckbrush, this plant life being heavier in the draws. On the Madera side the final slope is covered with bare granite rocks, grass and an occasional oak. The draws leading up to the slopes are dry and barren. Undoubtedly

the Fresno side receives more moisture than the hotter northwest slopes in Madera County.

For the first eight days of the 1940 study, camp was located about 75 feet from the river in an old diversion channel that formerly supplied water for the first flour mill in Fresno County. Later, fearing sudden floods, camp was moved to a spot about 100 yards downstream in a sandy area between the river and the diversion channel. This site was much more satisfactory, not only because it was better protected from floods, but also because it was cooler and freer from mosquitoes. In this area the San Joaquin is a series of smooth stretches that are occasionally broken by rapids.

On March 26, 27 and 28, 1937, a camp was set up about one mile below Old Fort Millerton, near the river. On April 24 and 25, 1937,

FIG. 57. Looking south across the old river bed. Camp was about 100 yards to right. Large valley oak (*Quercus lobata*) in right background. Hill in center background will become island. Lupines (*Lupinus sp.*) in foreground.

a camp was made across from Collins Springs, on the Madera County side of the river. May 29, 30 and 31, 1937 were spent in the area about one and one-half miles above the old fort on the Fresno side of the river. Vertebrates recorded on these trips have been included in the species accounts.

Approximately 100 traps ("museum specials") were set each night in rows of 20 traps each, the rows being about 50 feet apart. Thus an area the width of the strip, 200 yards, and about 250 feet long was covered each night. Gopher and rat traps were also set out. Birds were not collected except for purposes of identification. A list of species of birds and numbers seen was kept for each day. Examples of each species of amphibian and reptile observed were collected and preserved as museum specimens. Because of lack of time and facilities little attention was paid to fishes in this survey. Mention should be made, however, of larval parasitic lampreys

(*Entosphenus tridentatus*) and brook lampreys (*Lampetra planeri*) which were taken from the sand of the San Joaquin River bank on May 27, 1940.

Maximum and minimum temperatures were recorded each day the observers were in camp. Daily at 8 a.m., the humidity was taken by means of a sling-psychrometer. Specimens collected, some 240 in number, have been presented to the Museum of Vertebrate Zoology of the University of California.

## ACCOUNT OF SPECIES

### Amphibians and Reptiles

Amphibians and reptiles found:

California toad _____Bufo boreas (Baird and Girard)
Bullfrog _____Rana catesbeiana Shaw
Pacific tree-toad ____Hyla regilla Baird and Girard
Fence lizard _____Sceloporus occidentalis (Baird and Girard)
Alligator lizard _____Gerrhonotus multicarinatus (Blainville)
Whiptail lizard _____Cnemidophorus tessellatus (Say)
Western skink _____Eumeces skiltonianus (Baird and Girard)
Striped racer _____Coluber lateralis (Hallowell)
Boyle's king snake___Lampropeltis getulus boylii Baird and Girard
Pacific garter snake__Thamnophis sirtalis (Blainville)
Pacific rattlesnake __Crotalus viridis (Holbrook)
Pacific mud turtle___Clemmys marmorata (Baird and Girard)

#### California Toad

*Bufo boreas* (Baird and Girard)

Two California toads were collected in the area close to the pools of stagnant water in the old diversion channel about 75 feet north of camp, at night, by means of a flashlight. Four or five could be seen at almost any time in the evening, moving about near the ranch houses at Old Fort Millerton.

#### Bullfrog

*Rana catesbeiana* Shaw

Bullfrogs were numerous in the stagnant ponds in the old diversion channel. Four were taken at night by blinding them with a flashlight and shooting them with birdshot. They were not seen elsewhere. It is not known whether they were introduced at this location, or whether they came in from another place where they had been introduced.

It is probable that the frogs will survive the rise in water level which will come with the completion of the dam, but there will be no ponds such as there are at present in which they can breed. Whether they will become an important game species will depend largely on how they adapt themselves to the change in environment.

#### Pacific Tree-toad

*Hyla regilla* Baird and Girard

Numerous young tree-toads were seen in the vicinity of camp, especially in the moist portions of the diversion channel. Adults were heard on three or four occasions in the evening, but none was seen.

### Fence Lizard

*Sceloporus occidentalis* (Baird and Girard)

Fence lizards were by far the most common reptile in the area. They could be seen at almost any time of day, and in a variety of situations. Favorite locations were on rocks and logs near the river, but they were seen on rocks almost to the future water level. A young lizard about one and one-fourth inches in length was seen on the rocks of the Madera County side near the river on May 29, 1940. Almost 60 were collected.

### Alligator Lizard

*Gerrhonotus multicarinatus* (Blainville)

Only two alligator lizards were seen; both were collected. The first, a large adult, was shot by Boyer on May 26, 1940, in a pile of driftwood. The second, a young animal, was given to us by Mrs. Green, and was probably caught near the houses.

### Whiptail Lizard

*Cnemidophorus tessellatus* (Say)

Whiptails were fairly common in the water-worn granite rocks above camp, but seemed to increase in number starting June 5, 1940. Up to this date we had been unable to collect a specimen, but 14 were taken in the next five days. They seem to prefer fairly open, rocky areas. When disturbed, they move extremely fast.

### Western Skink

*Eumeces skiltonianus* (Baird and Girard)

A single skink, our only record for the area, was caught in a mouse trap, during daylight on April 25, 1937, at our Madera County camp site, across from Collins Springs.

### Striped Racer

*Coluber lateralis* (Hallowell)

One was shot on May 26, 1940, from about 10 feet up in a blue oak tree, and another collected in the rocks May 27, 1940. Both were adults.

### Boyle's King Snake

*Lampropeltis getulus boylii* Baird and Girard

Two full-grown Boyle king snakes were seen and collected, one on May 27, the other May 30, 1940. Both were taken on the sand within 50 feet of the river.

### Pacific Garter Snake

*Thamnophis sirtalis* (Blainville)

Three garter snakes were recorded and collected. The first was taken in grass near the river on May 29, 1940. It contained 15 young snakes (170 mm. long) in embryonic sacs; and from all appearances about ready to be born. Two more were collected on June 6, 1940, both near the river.

Pacific Rattlesnake

*Crotalus viridis* (Holbrook)

On June 1, 1940, a Pacific rattlesnake was shot and removed from an open gopher hole after it had bitten the writer's cocker spaniel. This snake was small, and had just finished ingesting a *Peromyscus (boylii boylii?)*. For these reasons, the bite was not as serious as it might have been. On June 9, 1940, another rattlesnake was taken, an adult. This one was resting in the rocks after a meal. The remains of the food were too far digested to be identifiable, but from the gray color of the fur, plus the large size, the victim may have been a wood rat (*Neotoma fuscipes*).

Pacific Mud Turtle

*Clemmys marmorata* (Baird and Girard)

Two mud turtles were taken in the pools in the diversion channel. The first of these was shot and preserved; the other was captured and brought, alive, to Berkeley. This second turtle had lost both front feet, apparently through an accident of some sort, only stubs remaining. Both turtles were more than six inches in body length.

## Birds

The summer months in this region are the poorest time of the year for observing birds, shore birds excepted. For this reason and because the area should be watched throughout at least a 12-month period to obtain an accurate record of its birds, no comment accompanies the birds listed below. The list is in A. O. U. check-list order, and the number in the column to the right shows the approximate (if accompanied by a plus-minus sign) or the exact numbers of each species observed between May 19 and June 9, 1940, with the exception of the Lewis woodpecker, specimens of which were collected on March 27 and April 18, 1936, and the red-breasted sapsucker, a specimen of which was collected on March 1, 1936.

Birds observed:

| | | |
|---|---|---|
| Great blue heron | Ardea herodias (L.) | 6 |
| Anthony green heron | Butorides virescens (Mearns) | 2 |
| Least bittern | Ixobrychus exilis (Gmelin) | 1 |
| Turkey vulture | Cathartes aura (L.) | 76± |
| Cooper hawk | Accipiter cooperi (Bonaparte) | 6 |
| Red-tailed hawk | Buteo borealis (Gmelin) | 2 |
| Sparrow hawk | Falco sparverius (L.) | 5 |
| California quail | Lophortyx californicus (Shaw) | 130± |
| Killdeer | Oxyechus vociferus (L.) | 36 |
| Mourning dove | Zenaidura macroura (L.) | 200± |
| Barn owl | Tyto alba (Scopoli) | 1 |
| Great horned owl | Bubo virginianus (Gmelin) | 1 |
| Black-chinned hummingbird | Archilochus alexandri (B. & M.) | 5 |
| Anna hummingbird | Calypte anna (Lesson) | 13 |
| Belted kingfisher | Megaceryle alcyon (L.) | 13 |
| Red-shafted flicker | Colaptes cafer (Gmelin) | 1 |

Birds observed—Continued

| | | |
|---|---|---|
| California woodpecker | Balanosphyra formicivora Swainson | 82 |
| Lewis woodpecker | Asyndesmus lewisi (Gray) | |
| Red-breasted sapsucker | Sphyrapicus varius (L.) | |
| Nuttall woodpecker | Dryobates nuttallii (Gambel) | 15 |
| Western kingbird | Tyrannus verticalis (Say) | 163± |
| Ash-throated flycatcher | Myiarchus cinerascens Lawrence | 25 |
| Black phoebe | Sayornis nigricans (Swainson) | 43 |
| Violet-green swallow | Tachycineta thalassina (Swainson) | 69± |
| Barn swallow | Hirundo erythrogastra (Boddaert) | 60± |
| California jay | Aphelocoma californica (Vigors) | 54 |
| Bush-tit | Psaltriparus minimus (Townsend) | 157± |
| Plain titmouse | Baeolophus inornatus (Gambel) | 42 |
| White-breasted nuthatch | Sitta carolinensis Latham | 4 |
| Canyon wren | Catherpes mexicanus Ridgway | 4 |
| Bewick wren | Thryomanes bewickii (Audubon) | 8 |
| Robin | Turdus migratorius (L.) | 2 |
| Western bluebird | Sialia mexicana Swainson | 18 |
| Phainopepla | Phainopepla nitens Van Tyne | 2 |
| Yellow-throat | Geothlypis trichas (L.) | 17 |
| Cowbird | Molothrus ater Boddaert | 20 |
| English sparrow | Passer domesticus (L.) | 4 |
| Bullock oriole | Icterus bullockii (Swainson) | 28 |
| Black-headed grosbeak | Hedymeles melanocephalus (Baird) | 61± |
| Brewer blackbird | Euphagus cyanocephalus (Wagler) | 278± |
| Linnet | Carpodacus mexicanus (Müller) | 196± |
| Green-backed goldfinch | Spinus psaltria (Say) | 7 |
| Brown towhee | Pipilo fuscus (McGregor) | 25 |

## Mammals

Mammals found in the Friant Reservoir area:

| | |
|---|---|
| Southern little California bat | Myotis californicus californicus (A. & B.) |
| Pacific pallid bat | Antrozous pallidus pacificus Merriam |
| California coon | Procyon lotor Gray * |
| Northern California striped skunk | Mephitis mephitis occidentalis Baird |
| California valley coyote | Canis latrans Eschscholz |
| California mountain lion | Felis concolor May * |
| California wildcat | Lynx rufus Mearns * |
| Fisher ground squirrel | Citellus beecheyi fisheri (Merriam) |
| California gray squirrel | Sciurus griseus griseus Ord |
| Fresno pocket gopher | Thomomys bottae pascalis Merriam |

Mammals found in the Friant Reservoir area—Continued

| | |
|---|---|
| San Joaquin pocket mouse | Perognathus inornatus inornatus Merriam |
| Long-tailed harvest mouse | Reithrodontomys megalotis longicaudus (Baird) |
| Boyle white-footed mouse | Peromyscus boylii boylii (Baird) |
| Gambel white-footed mouse | Peromyscus maniculatus gambelii (Baird) |
| Gilbert white-footed mouse | Peromyscus truei gilberti (Allen) |
| Streator wood rat | Neotoma fuscipes streatori Merriam |
| House mouse | Mus musculus Linnaeus |
| San Joaquin cottontail | Sylvilagus auduboni vallicola Nelson |
| California mule deer | Odocoileus hemionus californicus (Caton) * |

Southern Little California Bat

*Myotis californicus californicus* (Audubon and Bachman)

On May 29, 1937, nine bats of this species were found beneath the paper on the walls of an abandoned shack one and one-half miles above Old Fort Millerton. A female contained one embryo. All were made into skins.

Pacific Pallid Bat

*Antrozous pallidus pacificus* Merriam

One bat of this species was shot at dusk on May 30, 1937, as it flew outside the same abandoned shack in which the little California bats were taken.

California Coon

*Procyon lotor* Gray

On two separate occasions tracks of coons were seen in the sand at the edge of the river beneath a group of large black willows. Although the coon is on the list of predatory animals in California, it may become a valuable species in this area as a fur-bearer and as a sporting mammal. The sand-bar willow habitat to which it is seemingly accustomed will be flooded. It will be of interest to see whether this results in the animals moving from the area or in their adapting themselves to a change in environment.

Northern California Striped Skunk

*Mephitis mephitis occidentalis* Baird

On May 19, 1940, our first day in the Friant area, Boyer collected a female striped skunk in the rocks about dusk. The mammae showed signs of recent use, and she may have been suckling young. A "foxtail" weed was sticking into her left eye, probably causing blindness. Fleas and mites were removed from the body. No embryos were present. On June 7, 1940, while collecting lizards, Boyer was startled to see a large striped skunk less than four feet away from him in the same group of rocks, when he reached for a fence lizard which he had shot.

* Not actually observed.

Fortunately he had reloaded the .22 caliber pistol before reaching for the lizard, and he managed to fire a charge of birdshot into the face of the skunk, blinding it and allowing him to dispatch it with a solid shot from the same weapon. This animal was a large male. Neither skunk musked when it was shot.

California Valley Coyote

*Canis latrans* Eschscholz

On at least five separate nights the writer has heard coyotes howling in the Friant Basin. On one occasion (1932?) he recalls having found a dead coyote beside the river, which had apparently been poisoned and had died the night before.

California Mountain Lion

*Felis concolor* May

Shortly before his death the late Charles Green, Sr., for many years a resident of the Friant Basin and from whom the writer obtained much valuable and accurate information, stated that a female lion had raised a family near the base of one of the table mountains east of the Friant Basin. He said that Indians living in the area had been afraid to molest the lions, as they were armed only with .22 caliber rifles. It is probable that lions pass occasionally through the Friant Reservoir area.

California Wildcat

*Lynx rufus* Mearns

The deputy sheriff assigned to the Friant district from the Fresno County Sheriff's office told the writer that bobcats were seen occasionally in the Friant Basin above Old Fort Millerton, during the previous winter.

Fisher Ground Squirrel

*Citellus beecheyi fisheri* (Merriam)

Ground squirrels are common in the Friant area, although they have been greatly reduced in numbers in the last few years by poisoning and other control methods. They were seen occasionally in the rocky area above camp and were often observed on both the first and the second plateaus of the trap strip. One specimen was taken on the bank of a ravine just north of the first plateau.

California Gray Squirrel

*Sciurus griseus griseus* Ord

On five occasions gray squirrels were seen in the area. Of these the first, a young female, was collected from a black willow. All were seen within 200 feet of the river. An old miner on the Madera side reported a "tree squirrel" that was so tame that it would almost eat out of his hand. It seems late in the summer for these animals to be found so low when there is plenty of food in the Sierras. When the area is first flooded trees will be scarce around the border of the reservoir. Until a fairly good stand of trees grows, gray squirrels will not find

much cover, and will probably remain at higher elevations. It will doubtless be some length of time before the gray quirrels in California will increase to such numbers that they will again become an important game species and have an open hunting season.

### Fresno Pocket Gopher

*Thomomys bottae pascalis* Merriam

Pocket gophers are abundant in the basin. On the trap strip they were most numerous in the loosely packed, sandy soil near the river, but workings were seen on the second plateau where the soil is hard-packed. How large a part these gophers play in attracting animals which prey upon them can not be determined until more data are gathered in the area.

### San Joaquin Pocket Mouse

*Perognathus inornatus inornatus* Merriam

On the night of May 23, 1940, a young male pocket mouse was captured in the sand. Although traps were set out in this area almost every night from this date on, this is the only record obtained.

### Long-tailed Harvest Mouse

*Reithrodontomys megalotis longicaudus* (Baird)

A male harvest mouse was caught beneath a log near the San Joaquin River on March 27, 1940, at a point approximately three-fourths mile south of Old Fort Millerton. This is our only harvest mouse record in the basin.

### Gambel White-footed Mouse

*Peromyscus maniculatus gambelii* (Baird)

The Gambel white-footed mouse is a common mammal in the Friant Basin. A total of 71 was taken on trips in 1937, and about 40 on this latest trip. From our observations this species seems to prefer the more open areas, especially around logs, whereas in the closer, rocky areas the predominant mouse is *Peromyscus boylii*. Gambel mice were the only mice caught on the open plateaus of the trap strip; when the rocks at the base of the slope leading up to the future reservoir shore were reached, *P. boylii* again became predominant.

### Boyle White-footed Mouse

*Peromyscus boylii boylii* (Baird)

Boyle mice were found to be common in a variety of habitats in the trapped area. Again rocks seemed to be preferred, but they were found also on sand, beneath oaks and driftwood, in chaparral, and one pair endeavored to build a nest in one of our packing boxes! They are larger than *P. m. gambelii*, but the ear is smaller than that of *P. truei gilberti*.

### Gilbert White-footed Mouse

*Peromyscus truei gilberti* (Allen)

No Gilbert mice were trapped prior to the 1940 trip. This may be due to the fact that on previous trips we did no extensive trapping in rocky areas. On the last visit while not numerous they were taken in the rocks near the river, and again in the area just below the future shore of the reservoir. The species may be identified by the large body size (often over 200 mm.) and the relatively large ears (about 25 mm. in adults).

### Streator Wood Rat

*Neotoma fuscipes streatori* Merriam

Streator wood rats are abundant in the rocky portions of the Friant Basin. They prefer rocks to wood houses. Only two or three stick houses have been seen in the area; these were constructed at the bases of oak trees and not in the branches. Two young rats were trapped in runways of a small stick house built at the base of a blue oak. Four wood rats had previously been taken; one of these, a young one, was captured alive and successfully raised by means of a medicine dropper.

### House Mouse

*Mus musculus* Linnaeus

Two house mice were trapped, one on June 7, and the other June 8, 1940. One was caught among the rocks, the other on sand about 50 feet from the river. The nearest human habitation in this area is the Green Ranch headquarters about one-half mile south. There had been a cabin at the site of our second camp but it was washed away by the flood of 1937. One of these places must have been the source of the forerunners of these mice.

### San Joaquin Cottontail

*Sylvilagus auduboni vallicola* Nelson

Cottontails were numerous in rocky areas near the river, being occasionally seen as far back as the second plateau. A large male was collected on June 8, 1940. This game species will probably be as adaptable to the new environment as any now in the area. Rocks will be plentiful above the future water line, as will an ample cover of brush. It will be largely a migration with these rabbits, the change in habitat being secondary.

### California Mule Deer

*Odocoileus hemionus californicus* (Caton)

G. A. Hogue of the Bureau of Reclamation reported that some of the engineers working under his supervision had "jumped" a large (male?) deer in the area where the river canyon narrows north of Pincushion Mountain, about two miles north of Old Fort Millerton. Green told the writer that someone killed, out of season, a large buck that was almost a pet of his, a short distance from the ranch house, cut off the head and left the remainder to rot. This is a rather low elevation for deer to occur in any number. Food is so scarce in the

dry summer season that cattle must be fed. It is doubtful whether the reservoir will influence deer populations to any great extent. The migration from the Sierras to the foothills in winter may become more concentrated toward this area because of the water. Although this migration is usually started before the Sierra Nevada hunting season closes, much of it takes place after the season closes.

### Parasites

Ectoparasites were secured from many of the mammals collected. These have been identified by F. C. Bishopp and his staff of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, in Washington, D. C., and the results have been published separately (Journal of Mammalogy, vol. 22, 1941).

## POSSIBLE EFFECTS OF THE FRIANT RESERVOIR UPON GAME AND OTHER VERTEBRATE ANIMAL LIFE

Final effects of the Friant Dam upon the vertebrates of the area can be satisfactorily determined only by study after the reservoir has been filled. It is a known fact that when major changes of environment such as this take place, animals (and plants) do one or more of the following, closely interwoven things: (1) emigrate, (2) readapt themselves, or (3) perish.

### Emigration

It is certain that the course of emigration will be taken by most of the game and other animals, both vertebrate and invertebrate in the area, at least while the water is rising. The speed of this movement will be governed largely by the rate of rise of the encroaching water. As the water rises the concentration of terrestrial vertebrates around the edge will become greater, with an increase in the struggle for existence because of an increased demand upon the food resources and shelter of the area. It may be assumed that the critical period in the struggle for food will be when the water reaches the highest level of a *continuous* rise. A continuous rise would necessitate a continuous retreat. When this rise ceases, either temporarily or permanently, the emigration does not necessarily cease but may continue, allowing some of the animals to move into less-crowded areas where more food would be available. As was explained in the section on topography and as may be seen from the illustrations, there is a distinct change in habitat in going from the present river level to the future water level. This will necessitate a major change of habitat, including food and shelter, for many retreating species. Those able to adapt themselves may survive, while those unable to change their food and shelter habits will probably perish. For carnivorous species such as the gray fox, coyote, skunk and raccoon there will be an increased concentration of food during the period of retreat of the mice, wood rats, gophers and similar small mammals which serve as food to these carnivores. Raptorial birds will probably take their toll of small animals at this same time. The retreat from rising water may take place in the daytime as well as at night. If this happens it will mean that small animals will be subjected to more danger from predators in having to move through areas with little or no shelter.

Certain areas in the line of retreat between the present and the future water levels are entirely lacking in ground cover. To species which may cover a wide area in normal daily movements such as the deer, coyotes and mountain lions, the retreat from the rising water will offer no hardship, except that favored habitats, dens, etc., may be flooded. After the highest water level is reached there will continue to be in all probability a movement out of the areas of concentration because of population pressure until populations are reduced to the carrying capacity of the area and consequent stabilization results.

FIG. 58. View north from second plateau up the San Joaquin River, just before it makes sharp right angle bend and goes into narrows. Madera County on left side.

## Modifications

Among the modifications which may be suggested at this time as being possibilities would be adaptations to new types of food and cover. A graphic example of a change of available food may be seen in the turkey mullein (*Eremocarpus*) which is so abundant on the first plateau of the trap strip but practically absent on the second plateau about 100 yards farther in the line of retreat. The seeds of this species, an important food of the mourning dove, could (and may) be utilized by small rodents such as deer mice, and its presence or absence could mean life or death to the retreating animals. The rapidity with which these animals are able to adapt themselves to changes in food is an important consideration. The fact that several islands will be formed in the reservoir suggests a possibility that mutations as well as modifications may arise in the biota over a period of years.

## Death

Doubtless numerous small, terrestrial animals will perish with the flooding of the Friant Basin. Of these the highest mortality will probably be among fossorial species such as pocket gophers and ground squirrels, some of which are certain to be trapped in their burrows and

drowned, particularly if flooding takes place during the period of estivation or hibernation of the latter. Flooding may be cited as an indirect cause of death in instances such as small mammals falling prey to predatory mammals, birds or reptiles while retreating from the rising water, and in death resulting from failure to find food or to adapt themselves to new foods during retreat. There may be a psychological condition resulting among some of the animals affected by the flooding of the reservoir. Panic is likely to result among certain species or individuals as they are driven from the habitat in which they have made their homes, possibly into areas in which they have never ventured. This may be especially true with nocturnal species driven out in daylight. Such panic, especially if accompanied by a failure to find customary food (or food of any nature), may cause the animal to abandon usual caution, thus increasing the possibility of its falling prey to a predatory species.

The situation at Friant will doubtless add strength to the concept which has been stressed since the time of Darwin—that the animals having the greatest adaptability are the most likely to survive under changed conditions of environment.

### Aquatic Birds and Fish

Some water birds, not recently present at all or in numbers, will undoubtedly be again attracted to the area. "Old-timers" in the area, namely William Terrell and Charles Green, Sr., report that in years gone by there were huge flights of surface-feeding ducks and geese up the San Joaquin River. For example, Terrell, who has lived his entire life in the Fresno area, said that he had seen up-river flights of mallard and pintail ducks lasting for almost two continuous hours. These birds, he stated, fed during the night in the grain fields of Madera County and loafed during the day in the narrow canyon of the San Joaquin beyond Pincushion Mountain. (See Fig. 58.) The geese, mostly Canadas, fed during the day, moved up the river to spend the night, often at the same time that the ducks were coming down the river to feed. Green stated that flights of ducks and geese still occur at regular seasons but that the numbers of birds have become diminished during recent years. It is possible and indeed probable that the reservoir will again become an important resting and loafing ground for ducks, geese and other waterfowl. Probably it will not be of much value as a feeding ground, as there will likely be too much fluctuation (143 feet maximum) in the water level through the year. No important waterfowl food plants can grow under such conditions.

This fluctuation also makes the outlook poor for game fishing in the reservoir. Most fish lay their eggs in the warmer water near the lake shore. An increase in depth may prevent the eggs from developing, whereas a decrease would of course dry them up. The writer does not know what schedule will be followed in the releasing of impounded water from the reservoir into the valley for purposes of irrigation. It is possible that fluctuations of the water level could be controlled, at least for a brief period during the height of the egg-laying season of certain game species, as a management practice. Fish will doubtless survive if planted in the reservoir. The San

Joaquin River was once an important salmon fishing stream, but the run of these fish has steadily decreased. No fish ladder is being planned for the Friant Dam.

## NEED FOR FUTURE STUDY

Both economic and scientific aspects suggest the desirability of further study of this area as the Friant Dam is completed and the reservoir filled with water. The objectives include: adaptations of individual animals to new habitats; escape from and rate of retreat before the rising water; game and other birds attracted by the enlarged water surface; fisheries possibilities and actualities in the newly created lake.

## SUMMARY

Twenty-eight days of field study in the basin to be inundated with the completion of the Friant Dam of the Central Valley Water Project showed the presence of 72 species of vertebrate animals—12 reptiles and amphibians, 41 birds and 19 mammals. Other vertebrates are known to be present at other times during the year.

Many changes in the vertebrate animal life will be brought about by flooding the area; many animals will be driven from the area by the water, and other species, especially waterfowl, will be attracted by it. It is doubtful, however, whether the reservoir will be important as a feeding-ground for waterfowl or whether it will be of importance for game fishing, because the water level will fluctuate as much as 143 feet. It is important, both from the standpoint of scientific information and of practical wildlife management as related to the present and other proposed reclamation projects, that the effects of the new developments on the game and other vertebrates should be carefully followed by qualified field men.

## Weather Records

| 1940 | Sky | Temperature | | | Humidity, 8 a.m.* | |
|---|---|---|---|---|---|---|
| | | Max. | Min. | 8 a.m. | Wet | Dry |
| May 20 | Clear | 102° F. | 58° F. | | | |
| May 21 | Clear | 102° | 57° | 76° F. | 17° F. | 25° F. |
| May 22 | Clear | 92° | 69° | 80° | 19° | 27.3° |
| May 23 | Clear | 97° | 54° | 76° | 17° | 24° |
| May 24 | Clear | 94° | 58° | 78° | 18.5° | 25.5° |
| May 25 | Cloudy | 88° | 68° | 82° | 19.5° | 26.5° |
| May 26 | Clear | 90° | 49° | 86° | | |
| May 27 | Clear | 87° | 49° | 62° | 13° | 18° |
| May 28 | Clear | 82° | 51° | 63° | 9.5° | 16.5° |
| May 29 | Clear | 88° | 54° | 71° | 14° | 19° |
| May 30 | Clear | 91° | 60° | 78° | 12° | 22° |
| May 31 | Clear | 88° | 59° | 78° | 9° | 12° |
| June 1 | Cloudy | | | 70° | 9° | 12° |
| June 4 | Clear | 92°? | 56°? | | | |
| June 5 | Clear | 98° | 64° | 84° | 9° | 16° |
| June 6 | Clear | 100° | 65° | 87° | 9.5° | 12° |
| June 7 | Clear | 98° | 62° | 90° | 17° | 28° |
| June 8 | Clear | 100° | 66° | 84° | 16° | 26° |
| June 9 | Clear | | | 92° | 17° | 28.5° |

* Humidity read from sling psychrometer whirled for two minutes. Thermometers corrected: June 14, 1940: wet, 99.5° F., dry, 99.6° F. in boiling water (100° F.).

Maximum-minimum thermometer set beneath oak near river from May 20 to May 23, 1940; it may have been influenced by breezes.

Maximum-minimum thermometer beneath oak on first plateau about fifty feet above and 100 yards southeast of river from May 24 to May 27, 1940.

Maximum-minimum thermometer set on crest of slope from first to second plateaus from May 28 to June 9, 1940.

# ELEVENTH ANNUAL BLACK BRANT CENSUS IN CALIFORNIA[1]

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In the introduction to the previous brant census report,[2] the writer intimated that the present census might conclude this work. Since that time conditions unfavorable to brant have developed along the Pacific Coast in the form of marked reduction of eelgrass, the birds' principal winter food. Hence, it is believed to be desirable to continue the annual counts for an indefinite time in order to see what effect the eelgrass decline will have upon the brant population. Accordingly, another census is planned for February, 1942.

The eleventh annual brant census was taken in all of the usual localities save at Drake's Bay, on the customary date, February 10. It is much regretted that heavy rains which made roads impassable, prevented a census being obtained in 1941 at Drake's Bay, for this is now the only locality for which we do not have 10 satisfactory annual counts. The usual cooperators, members of the Bureau of Patrol of the California Division of Fish and Game who are named beyond, again assisted splendidly with this work. Grateful acknowledgment for this continued service is hereby made.

In the following report, results of the censuses in the various localities will first be provided, followed by remarks upon the eelgrass decline and other matters pertaining to brant.

## Humboldt Bay

Wardens L. E. Lahr and William Sholes took the census in this locality from shore. Due to storm conditions with rain falling throughout the day, it was found impractical to count from boat, as has heretofore usually been done. This year the birds were counted with the aid of binoculars in areas between prominent landmarks from strategic points overlooking the bay. The brant were found to be widely scattered in small flocks which made for accuracy in the count, although adding considerably to the amount of work. The birds did not move about much during the census taking so that chances of duplicating the counts were small. Accordingly, the observers believed that they obtained a fairly accurate census.

North Humboldt Bay was found to harbor 10,325 brant, and 39,675 birds were counted in South Humboldt Bay. The total census for February 10, 1941, was therefore 50,000 brant. This figure is approximately 11 per cent less than the 1940 total of 56,375 birds for Humboldt Bay, yet it is substantially above the 1932-1941, 10-year average of 40,915 brant for the locality.

[1] Submitted for publication, August, 1941.
[2] California Fish and Game, vol. 26, p. 381, 1940.

In view of the evident food shortage for brant which existed in Humboldt Bay and is mentioned beyond, the 1941 census total appears to be large.

**Bodega Bay**

Warden Bert Laws, who took the 1938 and 1939 censuses in this locality, again counted the brant this year. The bay was choppy from a fresh west wind, the sky was overcast, and rain fell. Laws counted

FIG. 59. Black Brant at Tom's Point, Tomales Bay, Marin County, California. Photographed March, 1940, by Paul J. Fair, U. S. Forest Service.

from vantage points along the eastern shore, using binoculars and a telescope. He reported that he was thus able to secure a fairly accurate count which totaled 555 brant.

This is the smallest number of brant that have been counted here in any of the 10 annual censuses since 1932, save in 1936, when only 350 birds were recorded. Since 1937, the numbers of brant censused in Bodega Bay have declined gradually, year by year, until 1940, when 1,050 were counted. The present census total is only slightly more than half of last year's result and is about one-third of the 10-year average of 1,520 birds. The progressive decline of eelgrass in this bay over the past three years, which reached alarming proportions by last winter, is thought to be the reason for the concurrent reduction in the numbers of brant visiting the area.

### Tomales Bay

Gordon H. True, Jr., Bureau of Game Conservation, Division of Fish and Game, and the writer took the 1941 brant census on Tomales Bay during the morning of February 10. The count was made as usual from outboard motorboat and the observers believe that the result is fairly accurate. Conditions for observation were good, with the sky overcast following rain before the census was begun, and with little wind. The total obtained was 1,540 brant.

This is the smallest number of brant that have been recorded for Tomales Bay in any of the 11 annual counts since 1931. In 1937, the next lowest count, 1,556 birds, was made. The 11-year average for this bay is 5,915 brant, and the 1932-1941, 10-year average is 5,562 birds. Thus, it will be seen how far below average the present census result falls. As in the case of Bodega Bay, the eelgrass decline is thought to be the factor responsible for the low brant population in Tomales Bay in 1941.

### Drake's Bay

Warden R. J. Yates, who made the three previous censuses in this locality, attempted to count the birds again this year. On February 10 and on several later attempts, he was unable to reach the bay due to the condition of the roads following heavy rains. Yates reported on February 27 that commercial fishermen operating off Drake's Bay had recently informed him of observing large numbers of brant coming to the bay from the south, for several days. This information plus the fact that the roads were still impassable at the end of February made it appear useless to attempt to secure a census at a later date.

The nine consecutive annual censuses obtained at Drake's Bay from 1932 to 1940, inclusive, average 2,656 brant per year.

### Morro Bay

Dr. A. P. Marshall and Warden F. W. Hecker of San Luis Obispo, who have both conducted several of the former censuses in this area, counted the brant together in 1941. The day was cloudy with occasional showers, but practically no wind blew and a satisfactory census was obtained. This totaled 6,302 brant of which about 1,500 were concentrated in the north-central part of the bay. About 4,000 others were found feeding on pickle-weed flats in the southeastern end of the bay where some of the birds were photographed by Hecker. (See Fig. 60.) This is unusual food for brant and the matter will be mentioned later in this paper. Shortage of eelgrass in the bay was, doubtless, the

reason for this abnormal behavior on the part of the birds. The remaining brant that completed the day's count were found scattered in small flocks all over the bay. After completing the census at Morro Bay, the observers drove north along the coast to Piedras Blancas. Since only a single brant was seen in the ocean on this trip it was assumed that most of the birds were in the bay, hence, that a satisfactory count of the brant of the vicinity had been obtained.

The 1941 census of 6,302 brant for Morro Bay is nearly a thousand birds less than the 1940 total and is far below the 1939 record count of 11,140 brant, yet it compares favorably with the average of 10 annual censuses for the area, 5,964 birds. Prior to 1935, relatively few brant were recorded in this area. That year, 7,544 birds were counted. The census fell to 5,000 brant in 1936, after which the num-

FIG. 60. Black brant feeding upon pickle-weed (*Salicornia*), an unusual brant food, southeastern end of Morro Bay, San Luis Obispo County, California. Photographed February 12, 1941, by F. W. Hecker.

bers gradually increased until the maximum was reached in 1939. The reduction in the numbers of birds observed since 1939 corresponds with results obtained in Bodega and Tomales bays where eelgrass depletion was occurring at the same time. This factor is also likely responsible for the reduced count obtained at Morro Bay in 1941, as against the previous two censuses.

## Point Mugu

Brant censuses were not conducted in this locality prior to 1940,[3] hence the results of the two annual counts thus far obtained are not included in the table beyond.

For the second year, Warden R. E. Bedwell counted the brant in this vicinity on February 10, 1941. He found the birds feeding and unsuspicious so he was able to approach within 100 feet of some; thus he obtained an accurate count of all, totaling 1,050 brant. A year previous, Bedwell counted 500 brant in this area.

In commenting upon the 1941 census, Bedwell advised that no indications of a shortage of eelgrass were noted at Point Mugu. In

[3] California Fish and Game, vol. 26, p. 384, 1940.

fact, he considered that there was sufficient of this food present to supply two or three thousand brant for the period that the birds customarily remain in the locality.

### Mission and San Diego Bays

Warden E. H. Glidden, who has conducted most of the previous censuses in this region, again led the 1941 count. He was assisted by L. M. Huey of the San Diego Natural History Museum and Maurice Weinberger of the San Diego Fish and Game Association.

Many brant were found scattered and in rafts on Mission Bay west of the Causeway Bridge. It was impossible for the observers to secure an accurate count of these birds but their conservative estimate totalled 2,500 brant. Only two brant were observed east of the Causeway Bridge. The figure of 2,500 birds was decided upon as fairly representing the number of brant present on that day. This is a substantial increase over the 1940 total of 1,395 brant. Since 1935, when only nine brant were found in Mission Bay, the censuses for this bay have grown steadily until it is now an important wintering place for the birds. The 1931-1935, five-year average for Mission Bay is less than 70 birds. None was seen in 1932. The 1936-1940, five-year average is 554 brant.

Larger than usual numbers of brant were also recorded by these observers on San Diego Bay on February 10, 1941. Here, 306 brant were found in a favorite place for these birds, off Cottonseed Point on the eastern side of the bay. On the western side, a mile south of Coronado Tent City, a group of 136 brant was counted. This made a total of 442 birds for San Diego Bay, which has been exceeded only once—by the record number of 462 brant censused in 1939. From 1931 to 1933 inclusive and in 1936, no brant were found in San Diego Bay. The average for the eleven censuses that have been made here is 157 brant. The birds seem to be increasing gradually in San Diego Bay, but not so rapidly as they have in Mission Bay since 1936.

In the following table are provided recapitulations of the eleven annual brant census results. In the last column are provided averages for the various localities. These averages are for from nine- to eleven-year periods, depending upon the number of annual counts obtained. The average for Drake's Bay is for only nine years. The averages for Humboldt, Bodega and Morro bays are for 10 years; and for the remaining localities, 11-year averages are provided. The total average is for 10 years only, eliminating the 1931 counts for Tomales, Mission and San Diego bays, and using the nine-year average for Drake's Bay. It may be noted that the 1941 census total of 61,339 brant for California compares favorably with the 10-year average total of 57,344 birds. Yet this year's total is approximately 19 per cent less than the 1940 total of 75,412 brant.

TABLE I

Recapitulation of California Black Brant Censuses, 1931-1941

| Locality | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 |
|---|---|---|---|---|---|---|
| Humboldt Bay | Unsatisfactory | 29,415 | 5,000 | 16,860 | 105,000 | 50,000 |
| Bodega Bay | None made | 3,200 | 977 | 1,298 | 3,700 | 350 |
| Tomales Bay | 9,445 | 6,285 | 7,409 | 5,565 | 6,850 | 9,175 |
| Drake's Bay | None made | 2,108 | 318 | 2,189 | 1,995 | 1,500 |
| Morro Bay | 4,493 | 2,938 | None made | 3,895 | 7,544 | 5,000 |
| Mission Bay | 71 | No birds | 115 | 154 | 9 | 30 |
| San Diego Bay | No birds | No birds | No birds | 7 | 55 | No birds |
| Totals | Incomplete | 43,946 | 13,819 | 29,968 | 125,153 | 66,055 |

| Locality | 1937 | 1938 | 1939 | 1940 | 1941 | Average |
|---|---|---|---|---|---|---|
| Humboldt Bay | 22,500 | 45,000 | 29,000 | 56,375 | 50,000 | 40,915 |
| Bodega Bay | 1,500 | 1,475 | 1,100 | 1,050 | 555 | 1,520 |
| Tomales Bay | 1,556 | 3,085 | 9,241 | 4,916 | 1,540 | 5,915 |
| Drake's Bay | 1,500 | 3,500 | 6,400 | 4,400 | None made | 2,656 |
| Morro Bay | 5,331 | 5,738 | 11,140 | 7,263 | 6,302 | 5,964 |
| Mission Bay | 450 | 325 | 570 | 1,395 | 2,500 | 510 |
| San Diego Bay | 350 | 397 | 462 | 13 | 442 | 157 |
| Totals | 33,187 | 59,520 | 57,913 | 75,412 | 61,339 | 57,344 |

## Notes on Brant Migration in California, 1940-1941 Season

Our earliest fall record for occurrence of brant in California was provided last autumn by Leonard Penhale, Department of Exhibits, California Academy of Sciences. On a visit to Bodega Bay, September 29, 1940, Penhale was near Bay Post Office at 4.30 p.m., when he noted a flock of about 50 brant flying to the bay from the north. The birds circled about the bay and then flew out to the ocean. A summary of the dates upon which brant have first been noted in autumn on Tomales Bay was provided in the eighth census report.[4] Up to that time, the earliest date of observation was of a few birds in that bay on October 19, 1934. The same year, H. C. Conrad[5] reported seeing about 300 brant in the ocean off Tomales Bay on October 14, 1934. This latter was the earliest seasonal record for California until Penhale's present observation.

The next observation of brant on Tomales Bay in the autumn of 1940 reported to the writer, was of a few birds seen by Chester Noran of San Francisco on October 15, 1940. No brant were reported seen on Tomales Bay from that date until November 3, when E. G. Schmiedell, Jr. saw a high flying, southbound flock near Inverness. The writer hunted for brant in the northern part of Tomales Bay and on the adjacent ocean the morning of November 11, 1940, but saw no brant. On his next visit, November 21, 1940, between 500 and 600 brant were observed on the ocean north of the entrance to Tomales Bay. These birds seemed to be reluctant to enter the bay to feed and did not do so until midafternoon. H. J. Jensen, a resident of Hamlet, Tomales Bay, stated that the first brant he observed near that locality last autumn were seen on November 18. This date apparently marked the arrival of the first winter visitants, for thenceforward fair numbers

[4] California Fish and Game, vol. 24, p. 344, 1938.

[5] California Fish and Game, vol. 20, p. 357, 1934.

of the birds were reported to be in daily evidence. It appears that the brant reported seen at Tomales Bay prior to November 18 were migrants passing through the region to more southern wintering places. This condition has been mentioned in several previous census reports and appears to be characteristic of the autumnal migration along the Pacific Coast. The early migrants pass through California, presumably to winter quarters in Lower California, and brant which remain on our bays to winter do not ordinarily arrive before November 10-20.

While fair numbers of brant were reported present on Tomales Bay from November 18, 1940 onward, throughout the winter, the total number present at any time was relatively small for the region. For example, on the writer's visits to the bay on December 14, 1940 and on January 26, 1941, far less than usual numbers of brant were seen. This fact was furthered by the low census result obtained in February, 1941.

Brant appear to have remained in California later last spring than is customary. Some late seasonal observations were published in the ninth census report [6] as follows: 300 to 400 brant on Tomales Bay on April 23, 1939; 86 brant still present there, May 1, 1939; 73 brant on Bodega Bay on the latter day. On a visit to Tomales Bay on May 7, 1941, in company with United States Game Management Agent H. M. Worcester, the writer found between 500 and 600 brant still present. The abnormal behavior of these birds, apparently due to eelgrass shortage, will be mentioned later. Possibly this shortage of the birds' normal food supply was responsible for their delayed northward migration.

### Brant Breeding at Humboldt Bay

The report in the previous census account [7] that a pair of black brant bred and produced four young near Buhne's Point, south Humboldt Bay, in the summer of 1940, incurred a number of comments expressing doubt of its correctness. Accordingly, efforts were made in the summer of 1941 to see if there might be a repetition of the nesting. Warden J. F. Hurley of Eureka was addressed on June 18, with the request to watch for nesting brant. He replied on July 30 that, although he had noted some brant on Humboldt Bay as late as June 10, 1941, he saw none after that date and hence concluded that none had summered this year. J. M. Davis, of whom similar information was requested, wrote under date of August 3, that he had been unable to find evidence of brant nesting this year. Davis saw four young brant near Buhne's Point on August 24, 1940.

On August 24, 1941, however, Davis wrote that three local hunters, who had been to a slough at the south end of Humboldt Bay on August 18, reported seeing two adult brant accompanied by seven young. These men asked Davis to check their identification so he went on August 23 to the locality in question where he soon found the entire family at close range. Upon receipt of this advice, a special permit to collect one of the young birds for the California Academy of Sciences was issued to Davis by the California Division of Fish and Game. He attempted to reach Elk River, where he had seen the birds, on August

[6] California Fish and Game, vol. 25, pp. 337, 339, 1939.
[7] California Fish and Game, vol. 26, pp. 386-387, 1940.

31, but rough weather prevented reaching the destination by boat. A week later, on September 6, Davis went by boat to Elk River, then on nearly to Table Bluff, near which he found the brant swimming on the bay. The two adults were in the lead, followed by the seven young. When the outboard motor was stopped about 200 yards from the birds, all flew off with ease. Davis wrote that he had no difficulty in distinguishing the young from the adult birds, on the wing. He was, however, unable to collect a specimen but advised that this year at least five people who know brant had seen the adult pair with the seven young. It seems no longer reasonable to doubt that a pair of black brant nested at Humboldt Bay in the summers of 1940 and 1941.

### Pacific Coast Eelgrass Shortage

Abnormal brant behavior which suggested a shortage of the birds' principal winter food, eelgrass (*Zostera marina*), was noted in the eighth census report.[8] This consisted of reports of brant feeding upon upland grasses at Humboldt and Tomales bays, on algae in the latter locality, and upon pickle-weed (*Salicornia*) at Morro Bay. Dr. Clarence Cottam of the U. S. Bureau of Biological Survey, who had previously had much experience with the eelgrass decline on the Atlantic Coast, and the writer inspected the eelgrass in Tomales Bay on July 21, 1938. Cottam found the plants to be apparently healthy and abundant growths were then encountered. Accordingly, no reason for immediate concern seemed to exist.

The writer was in the East in the autumn of 1938 and did not visit Tomales Bay after his trip with Cottam until November 26. At that time, brant were reasonably plentiful for the season[9] and no shortage of eelgrass was observed. It was subsequently noted however, from recent conversations with residents at Tomales Bay, that a considerable loss of eelgrass suddenly occurred in this bay in September, 1938. Both H. J. Jensen and Nick Kojick reported that windrows of eelgrass were washed up on the beaches in that month. Their accounts suggested that a similar but smaller loss than that photographed by Jewett near Netarts Bay, Oregon, on September 27, 1940 (see Fig. 61) had occurred in Tomales Bay about two years previously. Thus, the year 1938, or possibly the autumn of 1937, seems in the light of subsequent events to have marked the beginning of the current eelgrass decline in California.

In spite of this warning and the fact that observers were looking for indications of further eelgrass decline, no noteworthy shortages of the plant nor especially abnormal behavior of brant as a result, were reported in the following two winters. It appears now, however, that in this period from 1938 to the summer of 1940, a so gradual reduction of the plant as to be difficult to observe was progressing.

The winter of 1940-1941 brought in a number of reports of serious eelgrass depletion. On his first autumnal visit to Tomales Bay on November 11, 1940, the writer found that tremendous reduction of the plant had occurred since the previous spring. In some places hardly 25 per cent of a normal crop of eelgrass was present. The average

[8] California Fish and Game, vol. 24, p. 345, 1938.
[9] California Fish and Game, vol. 25, p. 339, 1939.

depletion over the entire bay was later estimated at about 60 per cent. In other words, only about 40 per cent of a normal crop was present.

This condition was speedily reported to both State and Federal authorities charged with fish and wildlife conservation. Paul Bonnot of the California Division of Fish and Game, made investigations early in December, 1940, which confirmed the fact that material reduction of eelgrass had occurred in California in the last few years. Bonnot could find no evidence that the blight which in 1931 destroyed most of the eelgrass on the Atlantic Coast of North America was contributing to the local decline. Rather, he suggested that deposits of silt several inches in excess of normal which had been brought down to the bays by the unusually heavy rainstorms of recent years, might be a cause for the present depletion. This is a theory which many local residents of our eelgrass bays believe to be the chief cause of the plant's decline.

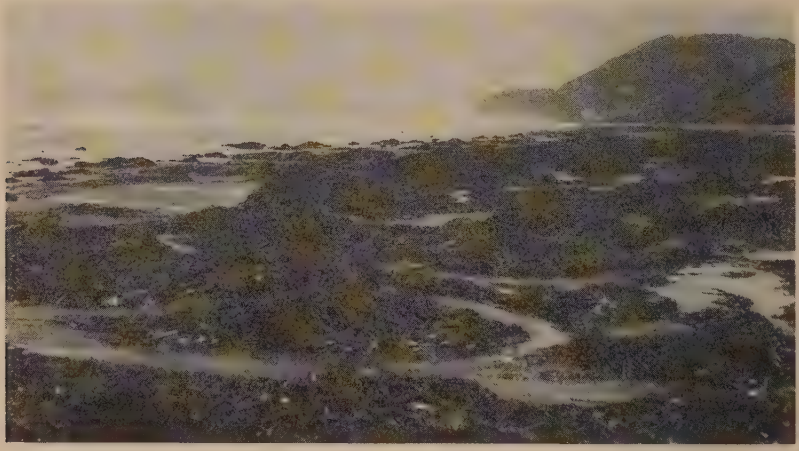

FIG. 61. Eelgrass and kelp washed ashore near Three Arch Rocks, Oregon Coast, near Netarts Bay. Photographed September 27, 1940, by Stanley G. Jewett, U. S. Fish and Wildlife Service.

Dr. Clarence Cottam, United States Fish and Wildlife Service, was especially interested in the Pacific Coast eelgrass decline because of his wide experience with the Atlantic Coast catastrophe. When the extent of the California losses was made known to him in December, 1940, he suggested that the writer join him in an investigation of the matter. This was done and the results have been prepared for publication in a paper of joint authorship now in press. It is expected that this review of the Pacific Coast eelgrass situation will be published in a United States Fish and Wildlife Service Wildlife Leaflet before the present census report appears in print. Greater details regarding the eelgrass decline are provided in this joint paper with Cottam than it appears necessary to relate here. Persons interested in reading the more extensive account may, it is expected, receive copies upon application either to the Fish and Wildlife Service, United States Department of the Interior, Washington, D. C., or to the present author.

Cottam's and the author's investigations revealed that eelgrass depletion now exists on the Pacific Coast of North America from Puget Sound to San Diego. The malady seems only recently to have reached the above extremities of the affected area and the consensus of many reports received tended to indicate that the trouble started along the northern California Coast in 1938. Canadian observers reported normal and flourishing crops of eelgrass on both coasts of Vancouver Island as recently as in April, 1941. A limited number of reports from central British Columbian and southeastern Alaskan localities indicated that normal eelgrass conditions still existed there in the spring of 1941.

Warden Glidden of San Diego has been of much assistance in investigating and reporting upon eelgrass conditions in his vicinity. On February 23, 1941, he found apparently healthy and abundant growths of eelgrass in Mission Bay. Up to that date, there were no reports of eelgrass decline from south of Morro Bay on the California Coast. Glidden inspected the eelgrass in Mission Bay again at the end of June. He then noted less eelgrass present than in February, although more should have been in evidence due to the spring growth. Glidden also observed that the eelgrass was abnormal in appearance and it seemed to have a slimy feel and to be coated with a deposit. He collected samples of the plants which were forwarded through Cottam to Dr. C. E. Renn of Harvard University. Renn is the discoverer of a parasite to the Atlantic Coast eelgrass, a mycetozoan, or low grade fungus-like organism known as *Labyrinthula*, which he described in 1936.[10] Renn and others believe that this organism is the factor which caused the tremendous decline of eelgrass on the Atlantic Coast in 1931. Under date of July 30, 1941, Renn advised that he had examined the Mission Bay eelgrass samples and that he had definitely determined presence of *Labyrinthula* in the material. This was the most positive report of several examinations of California eelgrass samples made by Renn that the organism was present. He thought the parasite was present in samples collected earlier in the year at Humboldt Bay by Lahr and in two lots collected in Tomales Bay by Moffitt.

The results of the examination of the Mission Bay material definitely proved that a species of *Labyrinthula* is present in West Coast eelgrass. Whether or not this organism is responsible for the current decline of Pacific Coast eelgrass is a debatable matter. It has never been proved that *Labyrinthula* caused the East Coast eelgrass catastrophe, but the majority of workers seem to feel that it was the responsible factor. In any case, the Pacific Coast decline has been much more gradual and to date much less severe than the attack in the Atlantic which destroyed most of the eelgrass plants within a few months' time. Even in areas in California where it now seems that the disease has been prevalent for nearly three years, there are still substantial amounts of eelgrass present. If *Labyrinthula* is the cause of the plant's disappearance, it seems that either the form of this organism on the West Coast is less injurious to eelgrass or the western plants are more resistant to its attack than was the case in the Atlantic.

Positive identification of the presence of *Labyrinthula* in eelgrass requires microscopic examination of specially prepared samples. The

[10] Biological Bulletin, vol. 70, pp. 148-158, 1936.

best results are obtained by examining fresh material, but a special preservative may be used in cases where it is impossible to get fresh samples to the laboratory. Arrangements to investigate samples of eelgrass for the presence of this parasite will be completed at the California Academy of Sciences, San Francisco, before this paper appears in print. Persons desiring to send samples for examination should address them to the writer. In cases where it is impractical to get material to the laboratory in fresh condition, application for preservative and directions should first be made to the writer.

Eelgrass attacked by *Labyrinthula* usually shows a characteristic spotting or blotching of the leaves which creates areas of a brownish or dark color due to destruction of the plant cells by this organism. A few sections of leaves which show this longitudinal streaking are all that are required for making an examination for the presence of the parasite. The disease also attacks the rhizomes or underground stems of the plants, causing areas of these to turn black in color and to be brittle due to their destruction by the parasite. The plants often break off at the rhizomes due to this destruction, whereupon they float to the surface. On a visit to Tomales Bay on July 16, 1941 with Cottam, we observed a number of floating eelgrass plants. Upon examining a number of these, the rhizomes of each were found to be black and brittle. The characteristic leaf spotting or blotching was also present on the leaves. There seemed to be no reason to doubt that presence of *Labyrinthula* had destroyed these plants. Cottam said that their appearance was identical with that of affected Atlantic Coast plants which he had seen.

In spite of this plant loss and evident presence of *Labyrinthula* there was on July 16, 1941, considerably more eelgrass present in Tomales Bay than was observed by the writer on his previous visit on May 7. This was accounted for by a satisfactory growth of young offshoots from old plants. None of these new plants seemed to be affected by the parasite, but many of the mature plants showed evidences of infection. This satisfactory growth for a while of new plants and their subsequent dying off, usually in the following autumn, was characteristic of the plant's efforts at recovery on the Atlantic Coast. It is therefore too early to state that the eelgrass of Tomales Bay is making a satisfactory recovery. We must wait until winter to be sure that a dying off in the autumn does not occur to reduce gains already made.

Elsewhere in California, the winter of 1940-1941 brought in numerous reports of eelgrass shortages and of abnormal behavior of brant as a result. In his report of the current census at Humboldt Bay, Lahr mentioned the marked shortage of eelgrass and the fact that large numbers of brant had recently been observed feeding in grass fields. In March, Lahr advised that he had recently seen a flock of 2,000 brant feeding on newly sprouted grass. At that time, he wrote, there appeared to be little eelgrass left in parts of Humboldt Bay. Where there had been fair growths the previous autumn, he found the plants to have been eaten off by March, presumably by brant, to a uniform depth about six inches below mean low water line. This condition had not been previously reported from Humboldt Bay, so it seems that a general lack of eelgrass in the region had made it necessary for

the brant to graze what was available to an unusual degree. The fact that many brant were found feeding in grass fields also indicated that a shortage of their preferred food, eelgrass, existed. J. M. Davis of Eureka also reported that unusual numbers of brant were observed feeding in pasture lands about Humboldt Bay in the spring of 1941. The Eureka Fish and Game Club through Eldon Crosby, Secretary, wrote to the United States Fish and Wildlife Service about the marked reduction of natural duck foods in Humboldt Bay in the spring of 1941. This communication, no doubt, referred principally to the local eelgrass shortage.

The writer observed a number of instances of unusual feeding behavior by brant on Tomales Bay in the course of investigations made last spring, all of which seemed most likely to be the result of eelgrass shortage. When taking the 1941 census with True, small flocks of brant were observed to be feeding upon grass growing in the sand dunes at the northern end of Tomales Bay. These birds were well above the water and back from the beach, in a most unusual situation for brant. Nearby, another flock was noted feeding upon pickle-weed at the edge of the bay. On a visit to the bay on May 7, 1941, Worcester and Moffitt observed much more unusual brant behavior. First, about 250 brant were found on the mud flats at the south end of the bay where brant are seldom seen. These birds were apparently eating sea lettuce, a green alga (*Ulva Lactuca*). Later the same day, many small flocks of brant totalling about 250 birds were found feeding apparently also on green algae, along the beaches on the western shore of the bay from opposite Hamlet to the ocean. At the same time, relatively few, not more than 100 brant, were feeding on eelgrass flats out in the bay. Other brant were closely observed just outside the entrance to the bay where they were feeding on rocks uncovered by the low tide. It was determined that these brant were eating rockgrass (*Phyllospadix*), a plant closely related to eelgrass but one that is not normally eaten to nearly the same extent by brant. While at this time the eelgrass supply in Tomales Bay was much reduced over former years, there were still considerable quantities of the plant within easy reach of brant at the time that the above observations were made. This eelgrass, however, except for the new growth then only a few inches long, was brown in appearance and was covered with a slimy deposit. It seemed that the brant must not care to eat this brownish eelgrass but that they preferred the other, although abnormal foods.

Yates reported on July 15, 1941 such a great decline of eelgrass in Drake's Bay over former years that he wondered why so many brant still visited the area as he found present in April and May of this year. He also advised that this spring near Bolinas Bay several hundred brant nearly ate up a farmer's pasture, in spite of efforts by Yates to drive them away by firing off shotgun shots.

Ben Glading of the California Division of Fish and Game, who is stationed at Pacific Grove, sent in the interesting photograph reproduced here (see Fig. 62) of 56 black brant on Pebble Beach Golf Course, 17-Mile Drive, Monterey County. He advised that the brant fed upon the grass of the golf course for a number of days, where their presence was disconcerting to the golfers. Efforts to frighten

the birds away, however, failed. This appears to be an exceptional instance of unusual brant behavior that was no doubt caused by shortage elsewhere of the birds' natural food.

Hecker's photograph (Fig 60) of brant feeding upon pickle-weed has already been mentioned under the Morro Bay census report. This succulent vegetation appears to be an unusual food for brant that is probably taken only at times of scarcity of the birds' staple winter food, eelgrass. In normal times, eelgrass appears to provide more than 80 per cent of the brant's winter diet. Under normal conditions, brant are seldom found for any considerable period of time in winter far from this favorite food supply. The correlation between this bird and plant is a close one. The brant's winter range on the Pacific and Atlantic coasts of North America corresponds with the distribution of eelgrass. In California, where many of our bays do not support

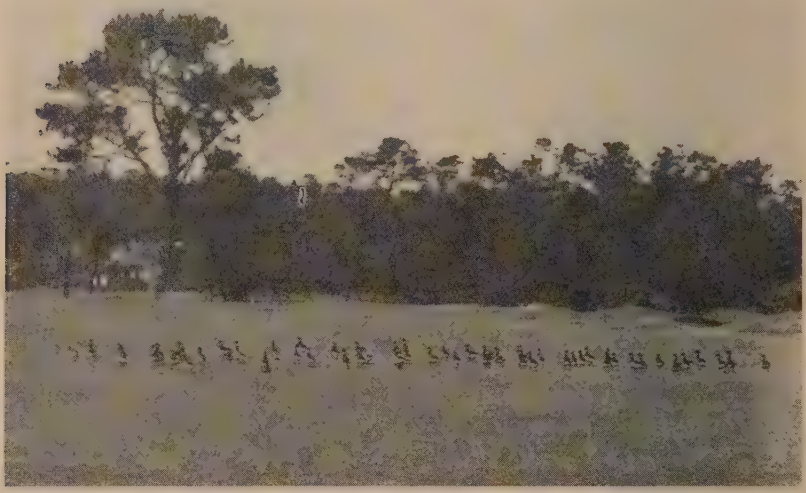

FIG. 62. Black brant on Pebble Beach Golf Course, 17-Mile Drive, Monterey County, California, where they fed for several days. Photographed April 3, 1941, by Ben Glading, Division of Fish and Game.

growths of eelgrass, we do not expect to find brant, but the areas which do support growths of this plant usually are visited by brant in winter.

The decline of eelgrass on the Pacific Coast is, therefore, a serious matter to the brant population. It is apparent from the above reports and from the reduced numbers of brant censused this year in the affected areas, that the eelgrass supply last winter was insufficient for the number of brant which wintered in California. If the eelgrass continues to decline next winter, as seems probable in view of experience on the Atlantic Coast, our wintering brant may be faced with an acute food shortage. After the great destruction of eelgrass on our East Coast in 1931, there followed a precipitous and alarming reduction in numbers of brant. By 1934, it was estimated that not more than 20 per cent of the normal brant population had survived. This

catastrophe resulted in a closed season being placed upon the species on the Atlantic Coast in 1933, which it has been found necessary to continue until the present time.

Following the great decline of eelgrass on the Atlantic, brant were forced to resort to all sorts of substitute foods. Many resorted to sea lettuce and others were found feeding in pastures, far from water and normal habitats. The situations were similar to instances above reported for California, but more extreme due to the greater decline of eelgrass on the Atlantic. As the food shortage grew more acute, brant on the Atlantic Coast became extremely poor and finally many died of starvation.

Our Pacific Coast eelgrass decline fortunately has not yet reached such alarming proportions, but in view of experience on the Atlantic, it will have to be watched carefully. The authorities in charge of wildlife conservation are fully aware of the dangers and it may be necessary either to close the shooting season entirely or to impose further restrictions upon brant gunning in the West, in order to preserve an adequate breeding stock of the birds. If the regulations which governed brant shooting last winter are continued, a proportionately larger kill may be expected due to the fact that the birds will be easier for hunters to approach in the unusual situations that they have been forced to resort to for feeding. It may be argued that since there already appears to be an insufficient supply of eelgrass for the present numbers of brant on the Pacific Coast, it would be preferable to reduce the brant population somewhat by shooting, rather than permitting all of the birds to reach a possibly dangerously low ebb of vitality, due to malnutrition, with the death of some by starvation the ultimate result. This humanitarian viewpoint may have much justice, but it is impossible at this time when regulations must be made to foresee what conditions may be next winter. Accordingly, it would seem to be dangerous to modify the regulations now and perhaps it would be safest to make them even more restrictive than heretofore.

Unfortunately, there does not seem to be anything that can be done to retard the eelgrass decline. On the East Coast, experimental plantings of West Coast and other samples of eelgrass in the hope of developing a strain that would be immune to the disease failed in this regard.[11] In spite of much work on the Atlantic, no means were found to alleviate conditions that continued for several years after the inception of the blight in 1931. During this period, sporadic attempts of the plant to reestablish itself were characteristic of the disease. These efforts at recovery covered a wide range whence numerous local growths were reported, but most of them were short lived and usually by the following autumn the gains were lost by another period of dying off. By 1940, however, substantial recoveries amounting to from 10 to 50 per cent of normal were reported in some areas.[12] By this time it was estimated that although encouraging improvement was thus evidenced, the plant was perhaps only 10 per cent as abundant as it was 10 years ago. In view of this experience on the Atlantic Coast, the outlook is not bright for the future in the West. Apparently all that interested

[11] Cottam, C. U. S. Bureau of Biological Survey. Wildlife Research and Management Leaflet, BS-110, p. 6, 1938.

[12] Cottam, C. U. S. Dept. of Agriculture. Plant Disease Reporter, vol. 25, pp. 48, 51, 52, February, 1941.

persons can do is to watch the situation closely and to secure as much information as possible about the disease, in the hope of developing some remedy. Hence, the situation will be closely watched in the future and reports will be made as appears to be desirable. In this connection, hunters and local residents of eelgrass bays can be of assistance by reporting conditions that come under their observation, and such cooperation is cordially invited.

Favorable to brant on the Pacific Coast, in the event of disastrous eelgrass depletion, is the fact that there appear to be more substitute foods for eelgrass which brant will eat than occur on the Atlantic seaboard. Most of our bays where brant regularly visit have considerable supplies of green algae (Ulvaceae), which, while not high in nourishment, supply some food value. Pickle-weed (*Salicornia*) is an abundant plant of the higher marshes bordering our brant bays, which experience has shown the birds will eat. Then rock-grass (*Phyllospadix*) occurs on many of our rocky shores, especially along the ocean. This appears to be a good food for brant and one which they like to eat. During the period of eelgrass scarcity at Tomales Bay last autumn, brant were observed to be feeding to a greater extent than in former years in the ocean off the bay. During the period from November 21 to December 1, 1940, the writer preserved for analyses, the stomachs of 14 brant which had been shot at the mouth of Tomales Bay, as the birds came from the ocean. These were later sent to the United States Fish and Wildlife Service for analyses of their contents. The results showed that of the entire lot, eelgrass amounted to 47 per cent of the food by bulk and rock-grass, 51 per cent. Three of these stomachs contained only rock-grass and remains of this plant predominated in three others. The percentage of rock-grass occurring in these stomachs was much higher than in the cases of brant collected in Tomales Bay in former years, before the eelgrass scarcity.

### Defense Activities and Brant

Nearly all of us are in favor of the present program for national defense, yet these activities are affecting and interfering with our daily lives. So the writer wishes to point out some instances of how this program has already adversely affected brant, simply as a matter of information, and by no means to be taken as criticism of this important step in national welfare.

In Tomales Bay, there has recently been set aside as an Army airplane practice bombing area, a portion of the bay that has been particularly favored by brant. This area lies between Tom's Point at the northwest and Preston Point, which is just north of where Walker Creek enters the bay near Hamlet, at the southeast. The bombing area includes that part of the bay which lies to the northeast of a line between Tom's and Preston points. Normally, much eelgrass grows in this portion of the bay and it has been one of the best local feeding areas for brant and greater scaup ducks (*Nyroca marila*). It is understood that the Army intends to use here only water, and not explosive bombs, but such airplane activity as will result will likely frighten many brant and other waterfowl from this and neighboring parts of the bay. It does appear that some other area, less attractive to waterfowl, might have suited the bombing requirements equally well.

As yet rather indefinite plans have been advocated for the past year or more for the reclamation of Morro Bay. One plan was to dam the narrow entrance to the bay behind Morro Rock and thus prevent the entrance of salt water and eventually to make a landlocked freshwater lake of the present bay. If this plan worked, which seems doubtful because of probable seepage of salt water from the ocean through the narrow sand-ridge which forms the western side of the bay, great ecological changes would occur in the bay. These would include destruction of all of the eelgrass, which requires fresh salt water in which to grow. This would result in brant no longer visiting the bay, and would thus permanently destroy this important wintering area for the species. We understand that this plan is not a defense measure but that other activities which are connected with defense are planned for Morro Bay. These have not, as yet, been definitely

FIG. 63. Black brant flying just south of Tom's Point, Hog Island in the center background, Tomales Bay, California. The proposed airplane practice bombing area lies immediately to the left of this view. Photographed March, 1940, by Paul J. Fair, U. S. Forest Service.

announced and it is hoped that they can be arranged so as not to interfere too severely with the usefulness of Morro Bay as a wintering place for brant.

In his report of February 24, 1941, on eelgrass conditions in San Diego Bay, Glidden advised that the bay had been undergoing "fast and furious" changes due to defense activities. At that time, seven dredgers were working in the bay and Glidden stated that silt resulting from their operations was covering many acres of eelgrass, and further, that additional reclamation of parts of the extreme southern end of the bay by a salt company was reducing the acreage of eelgrass. In the past, he wrote, this had been one of the birds' favorite feeding areas. Airplane activities were much increased over the bay, but they did not seem to drive the brant away. Rather, upon being disturbed by the planes, the birds simply moved to another part of the bay. Glidden advised that the proposal to cut a channel from the bay to the ocean at the extreme south end of the bay, would, if carried out, undoubtedly ruin the best remaining eelgrass beds near the mouth of the Sweetwater River, and thus cause brant to leave San Diego Bay permanently.

On a later eelgrass inspection at the end of June, Glidden had difficulty in finding enough eelgrass for samples. He attributed the fact to the operation of the dredgers, although the eelgrass disease may also have been a cause for the great reduction of the plant.

## Summary

A census of black brant (*Branta bernicla nigricans*) was made in California on February 10, 1941. Counts were obtained from localities in which the species has been censused upon this approximate date, for the past 10 or 11 years, except that no census was made at Drake's Bay in 1941.

The total census result was 61,339 brant, which is somewhat above a 10-year average of 57,344 birds for all of the localities. The 1941 total was, however, about 19 per cent less than the 1940 result of 75,412 brant. Unusually small numbers of brant were recorded for Bodega and Tomales bays in 1941, while the Morro Bay census was below those of the previous two years. The Humboldt Bay census was well above the 10-year average, but it was 11 per cent lower than the 1940 total. Mission and San Diego bays produced unusually large totals. A record high count was obtained in the first locality, whereas in San Diego Bay the 1941 total was only exceeded slightly by one of 10 previous annual counts.

The earliest seasonal record of brant occurrence in the fall migration in California was made at Bodega Bay on September 29, 1941. Previous to this, the earliest observation on record was of brant seen off Tomales Bay on October 14, 1934, 15 days later than the present record.

A shortage of eelgrass, the principal winter food of brant, which probably began in 1938, reached alarming proportions in California bays from Morro Bay north by the winter of 1940-1941. It is thought that this shortage of natural food may have been responsible for the exceedingly small censuses obtained in 1941 in Bodega and Tomales bays, and for the reduced counts obtained in Humboldt and Morro bays over the previous season.

Details of the eelgrass decline are discussed with remarks upon abnormal behavior of brant observed last spring, apparently a result of food shortage. The extent of the present eelgrass decline on the Pacific Coast is also discussed. The affected area now extends from Puget Sound to San Diego; but the decline did not commence at San Diego until between March and June, 1941.

The organism *Labyrinthula*, the presence of which many workers believe caused the great eelgrass decline that began in the Atlantic in 1931, was found to be present in eelgrass samples collected in Mission Bay near San Diego in June, 1941. Presence of this parasite was also strongly suspected in material collected earlier in the year in Humboldt and Tomales bays. It is suggested that this organism may be the cause for the West Coast eelgrass decline.

The effects of the eelgrass depletion upon the brant population are discussed. Even last winter, the supply of eelgrass appeared to be insufficient for the numbers of brant that wintered in California. If the decline continues, as seems probable in view of the experience in the Atlantic, an acute food shortage for brant may develop in the

future. On the Pacific Coast there appear, however, to be more substitute foods for eelgrass which brant will eat than exist on the Atlantic.

Authorities in charge of wildlife conservation are aware of the situation. It may in the future be necessary to impose further restrictions upon gunning for brant, or even to close the season entirely on the Pacific in order to preserve an adequate breeding stock, as was done on the Atlantic Coast from 1933 to date.

Some instances of how national defense and other activities have recently adversely affected brant in California are mentioned.

# RESULTS OF THE SOUTHERN CALIFORNIA QUAIL BANDING PROGRAM[1]

*By* FRANK RICHARDSON
*Bureau of Game Conservation*
*California Division of Fish and Game*

During the last nine years about 65,000 quail have been banded and liberated in southern California. Hunters have occasionally shot these birds and less often banded birds have been found dead from other causes. The bands from these quail have been sent to the California Division of Fish and Game, which now has returns for 824 banded quail. Certain information has already been gained from these returns and utilized. True[2] has well analyzed the results of the first two years of the banding program. Now a more complete analysis and comparison of data of the several years enable further interpretations. At the same time it must be remembered that the somewhat fragmentary information derived from a banding study can not always lead to broad and definite conclusions because of the many variable factors. In studying bird migration, banding has often provided very definite answers, but the complex problems, such as that of the establishment of our liberated California quail, are rarely capable of such definite answers. We must carefully consider what can be learned from the work thus far accomplished and then continue the banding and liberating program, applying and testing management practices suggested by the knowledge gained.

The quail banding study is based on two essential steps—banding and liberation of quail by the State, followed by the return of bands by hunters and others finding them. The results of the program can be fairly well divided into two types—what can be learned from the number and general time of returns compared to liberations over a period of years; and what can be learned from the exact circumstances of the recovery of the individual bands.

## Number of Returns

### Factors Determining Returns

The number of bands returned in a given year to the Division of Fish and Game is dependent on many factors. The chief of these variables may be listed and briefly commented upon:

1. Number of quail liberated during the year in question and the previous few years.
2. Regions of liberation, that is, whether open to hunting or not. Subsequent moving of the birds and the time involved are factors.
3. Time of the current year (especially in relation to quail season) when birds were liberated. Mortality due to natural causes and the distance the quail move from the point of liberation are involved.

[1] Submitted for publication, August, 1941.

[2] True, Gordon H., Jr. Quail banding returns for 1932 and 1933. California Fish and Game, vol. 20, no. 4, pp. 371-374, 1934.

4. Proportion of bands returned of those found. Lack of interest or understanding, forgetfulness, and shooting out of season are contributing factors here.
5. Undiscovered death of banded birds, such as that caused by predators and disease.
6. Number of hunters in general. The number has continued to increase but other factors, such as weather, combine to determine the number during any one season.
7. Encountering of banded quail by hunters. The element of chance is strong here.
8. Hunting methods used, including the efficiency of retrieving dead or wounded birds.
9. Climatic and other factors affecting the season's quail kill.
10. Length of the quail season. This has been the same in southern California (November 15-December 31) since 1935. The bag limits have also been the same over this period.
11. Source of the liberated quail, that is, whether wild-trapped or raised on a game farm. Game farm birds, although consistently liberated on refuges, would be relatively easy to hunt if they wandered from the refuge soon after liberation.

## Comparison of Yearly Returns

Close comparison of the number of returns of different years is made impossible by the above variables. However, many of the factors (such as items 2, 4, 5, 6, 7, 8, 9 and 10) are reasonably comparable from one year to the next, and the most important variable (number 1) can be accurately determined. Table 1 thus compares the number of returns during a given year to the number of banded birds liberated that year. The total number of bands returned in a year is not significant unless the total liberations of that year and previous years are considered.

TABLE 1

Southern California Quail Banding Returns

| Year | Total banded | Total returns | Age and number of bands of a season's returns | | | | | | | | | Percentage of current year's returns | Total percentage of returns |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | | |
| 1932 | 2,200 | 10 | 10 | | | | | | | | | 0.45 | 0.73 |
| 1933 | 7,800 | 59 | 6 | 53 | | | | | | | | 0.68 | 0.87 |
| 1934 | 14,110 | | Closed season | | | | | | | | | | 0.49 |
| 1935 | 9,185 | *141 | | 7 | 56 | 77 | | | | | | 0.84 | 1.14 |
| 1936 | 14,000 | **141 | | 7 | 5 | 20 | 107 | | | | | 0.76 | 1.09 |
| 1937 | 5,875 | 153 | | 1 | 6 | 7 | 39 | 96 | | | | 1.63 | 2.06 |
| 1938 | 7,038 | 94 | | | 2 | | 4 | 16 | 72 | | | 1.02 | 1.36+ |
| 1939 | 2,885 | 108 | | | | 1 | 3 | 8 | 17 | 79 | | 2.74 | 3.92+ |
| 1940 | 1,595 | 85 | | | | | | 1 | 7 | 34 | 43 | 2.70 | 2.70+ |
| Totals | 64,688 | 791 | 16 | 68 | 69 | 105 | 153 | 121 | 96 | 113 | 43 | | |
| 1935-40 averages | 6,763 | 90.2 | | | | | | | | | | 1.61 | 2.04 |

The number of returns during any one year is not significant except when the year of liberation and the number of birds liberated that year is considered (see the last two columns of percentages). The center columns, however, show the distribution of returns over the several years. The hunting season may be referred to rather than the year as almost all bands are obtained during quail season. The plus signs after the total percentage of returns for the last three years indicate that more returns can be expected for these years. See text for further discussion of table.

* In addition, 16 birds banded in 1935 were killed by orange tree fumigation.

** In addition, 17 birds banded in 1936 were killed by orange tree fumigation.

The columns in table 1, giving the number and age of bands returned each year, show when and how many bands of birds liberated a certain year were returned. For example, in 1937 there were returns

for 96 of the 5,875 quail banded and liberated that year. Reading down the column we see that there were 16 more returns of 1937 birds in 1938, eight in 1939 and one in 1940. Reading across these columns one sees that in 1937, for instance, one band of 1933 was returned, six bands of 1934, seven of 1935, 39 of 1936, and 96 of 1937, making the total of 153 bands returned in 1937. Thus, any one number in these columns represents both the part of the *total bands returned* for the year of the horizontal column and the number of returns that year of the *total birds liberated* the year of the vertical column.

The column giving the percentages of returns of bands of the current year allows camparison. (The returns of the first two years are not included in this discussion or in the averages of table 1 since the newness of the system undoubtedly lowered the returns. Furthermore, the returning instructions on these first bands were less satis-

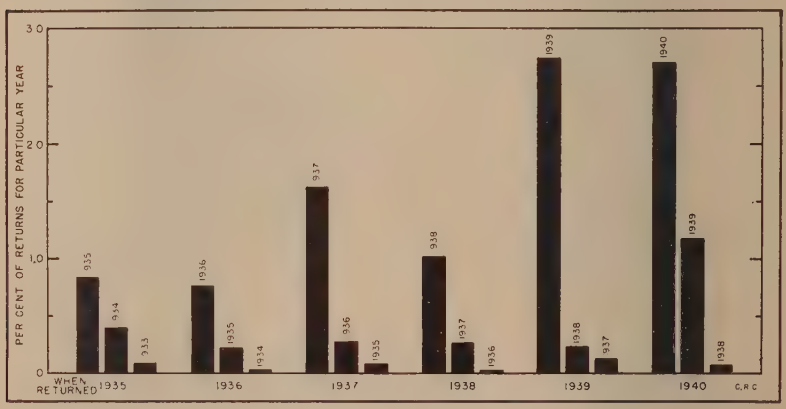


FIG. 64. Percentages of returns from banded quail of each year's banding. The percentages are grouped to show the composition of the returns of a single year. Returns on bands three or more years old are not included.

factory than later.) As few as 0.76 per cent of a year's bands were returned one year, but as many as 2.7 per cent another year. The last two years show a marked increase in the relative number of returns. This is probably due to increased publicity of the program, especially during 1940, and the relatively much greater number of quail released in areas open to hunting. This latter factor probably explains the general increase in returns over the last several years. The trend has been to liberate more wild-trapped quail in areas open to hunting rather than to liberate farm-raised birds on refuges.

The recent publicity campaign, consisting of distributing explanatory notices to the chief sporting goods stores in southern California and in writing articles for several of the leading newspapers, alone seems to have increased the 1940 band returns. This increase is shown graphically in the histograms of figure 64. The percentage of returns of the current year bands and of the bands of the previous year is either as high or decidedly higher in 1940 than in any other year. Undoubtedly greater publicity in future years may lead to relatively more band returns.

Evaluation of the total returns of bands of a certain year (as shown in the table) is also significant. The percentage of returns is lowest the first three years because of the newness of the program and the effect of the closed hunting season in 1934. The final totals for the last three years are necessarily increasingly incomplete, but nevertheless increased returns for the last two years are still obvious. The histograms of figure 64 show the basis for these total percentages of returns of a year's bands, omitting however the relatively insignificant number of bands returned three or more years after liberation. The variation and the marked increase of the last two years in the percentages of returns are well shown in the histograms.

The effect of the closed season of 1934 on banding returns is of particular interest. It was to be expected that the mortality among banded quail due to factors other than legal hunting would continue during the closed season more or less as in other years. That this was the case is reflected at least in part by the very low total returns for the banded birds released in 1932 to 1934, the only years the returns of which could have been affected by the closed season. The decreased total mortality among banded quail because of the closed season is indicated by the relatively high percentages of returns in years subsequent to 1934 for quail banded in 1933 and 1934. The 0.4 per cent return of 1934 quail in 1935, for instance, is markedly greater than the percentage of returns in the second year for any year from 1935 through 1938 (see histograms). The fact that the 0.4 per cent of 1934 quail returned in 1935 is not as high as any first or current year's returns, again reflects a probably high natural mortality of banded quail during the closed season of 1934.

The return average of 2.04 per cent for bands of a year indicates that we learn the fate of a little over two out of every 100 quail liberated in a given year. Other quail bands are undoubtedly found but not turned in, but probably a good half of all the bands found are returned. Consequently, we can say that on the average, well over 90 per cent of the quail released either meet a natural death or continue to live and have breeding potentialities. Further analysis of banding returns must be based on the information from individual birds.

## Information From Individual Returns

Although the total numbers of returns on banded quail give definite indications of the progress of the banding program, most of the fundamental questions must be approached by studying individual band returns. Certain questions such as how long quail live after liberation can be readily answered on the basis of extremes in the individual records. Many basic problems, too, demand an analysis of the individual records and a grouping of them according to various conditions such as when and where liberations were made, whether on a refuge or not, or whether the birds were wild-trapped or raised on a game farm.

This second section of the present article, then, analyzes the individual banding returns. The basis for the analysis is the 755 returns for the past six years. These returns with information pertaining to liberations have been grouped according to year, county and sequence. In gathering evidence for any given problem, returns or

groups of returns have been selected wherever possible over the whole period. All discussion is of valley quail, unless otherwise mentioned. The 36 Gambel quail returns and the two mountain quail returns are included, however, in the general treatments of ages and distances. They are also considered separately, in so far as it is possible to do so with such small numbers of returns, as to the major question of establishment.

**Degree of Completeness of Returns**

Some bands are returned to the Division without any date, locality or name and address of sender. Such returns are practically useless and have not been included in this study. Even a good many of the 755 returns used are incomplete with regard to some part of the information requested. Most often the point of capture of the banded bird is not described closely enough to definitely locate it on a map. Consequently, in studying the distances from points of liberation of captured birds, just 633 of the 755 returns could be used. Even many of these could not be located accurately enough to do more than estimate the distance to within a mile or two. In many returns the exact date of capture has been omitted so that just 715 of the 755 valid returns could be used. Where just the hunting season is given as the date, the mid-point of the season is used in computing the elapsed time since liberation.

Occasionally additional information of value is included with returns. The principal type of data has related to whether the banded quail were shot with either unbanded or other banded birds from the same covey. Estimates of the sizes of coveys are also received but are not of much value because of great variation in covey size and in the finder's personal judgment of it. Reported deaths of quail from causes other than hunting are considered separately later in this article.

Notwithstanding the incompleteness of some of the returns and the many factors which determine the number of returns, there are still certain conditions which make a comparison and interpretation of returns possible. Chief among these are the yearly banding and liberation of large numbers of quail, the regular hunting season (November 15-December 31) in southern California every year since 1935, and the large and fairly constant numbers of hunters which tend to be distributed with some regularity over the suitable quail country within a large radius of each point of liberation. (This last factor is confused somewhat by the fact that many liberations have been made on or near refuges.)

**Periods of Freedom**

The time intervals, called the ages of returns for convenience, between the liberation and capture of quail, are plotted on figure 65. The preponderance of returns during the first year after liberation is striking: 72.2 per cent of the total of 715 age records come within this period, 20.8 per cent of the returns are from the second year, and 3.9 per cent from the third. Not shown in the figure are the 2.4 per cent of the returns from the fourth year and 0.7 per cent from the

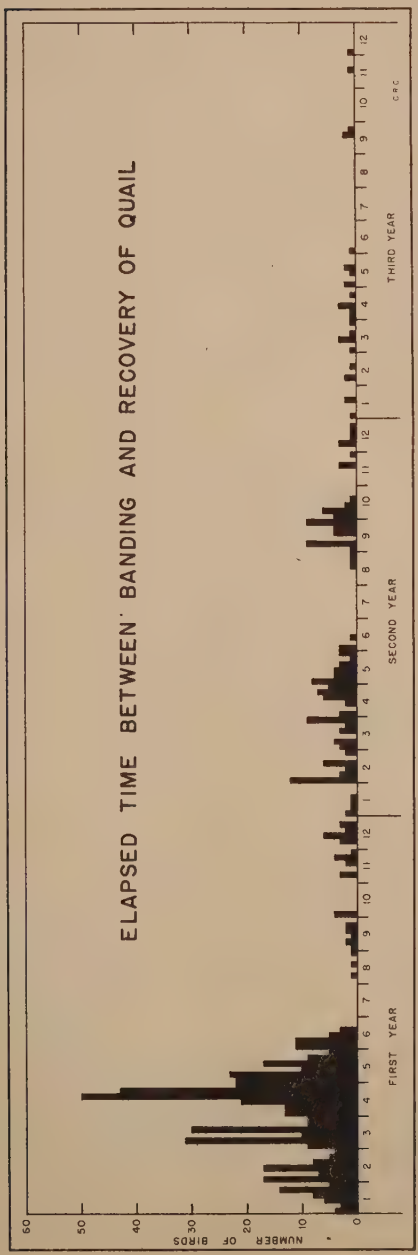


FIG. 65. Periods of freedom of liberated quail, combined into five-day intervals. The period of time between the liberation and capture of each banded quail is plotted in years, months and days. The 22 returns of over three years are not shown in this figure. (See text.)

fifth. Comparison of just the first two years indicates either that there is a specially high mortality among banded quail due to hunting the first season after liberation or that there is a high natural mortality before the second hunting season. With wild-trapped birds the latter explanation seems more likely as there is no apparent reason for an abnormal mortality the first season. Most liberations are made several months before quail season and the birds would almost necessarily have become well adjusted to their new locality in that time. Quail raised on a game farm, however, would be likely to suffer a higher mortality during the first hunting season as their fear of man or shooting would not yet be as highly developed as in the wild birds. However, practically all farm-raised quail have been liberated on refuges and although many of these birds are known to leave the refuges (see section on establishment of farm-raised compared to wild-trapped birds), the majority usually stay. The high natural mortality is thus made more likely. Plottings of ages of returns of wild and farm quail show a very comparable distribution of age returns.

A very interesting confirmation of the natural death rate conjectured above is provided in Sumner's work.[3] He calculates from field counts that of 100 quail, 26.8 per cent will be alive at the end of a year, 7.2 per cent at the end of two years, 2.0 per cent at the end of three years, and 0.5 per cent at the end of four years. His figures were rather closely borne out by retrapping records. In the present study, using the age of banding returns as an indicator of mortality by assuming the number of banded birds returned to be about proportional to the number left, a close parallel to Sumner's figures is seen: 27.8 per cent of the returns are after one year, 7.0 per cent are over two years, 3.1 per cent are over three years, and 0.7 per cent are over four years. It thus seems that the life expectation of liberated quail closely approaches that of wild or resident quail and is not shorter as might be thought.

The grouping of age returns, especially in the first six months (for example, 92.5 per cent of the returns during the first year are from the first six months) but also near the ninth and again in the eleventh and twelfth months, is very noticeable in the first three years after liberations. These groupings reflect the principal times of liberations of quail: the chief time of release from near the end of July to the start of the hunting season giving returns from 0 to over 5 months or whole years more than this; the early spring liberations of March and late February giving returns near 8 and 9 months or whole years more; and liberations in early January soon after the hunting season, giving returns during the eleventh and twelfth months or whole years more.

Five band returns are from birds released more than four years before recovery, the longest period of liberty being four years, nine months and 10 days. This bird must have been over five years of age when killed and was probably at least five and one-half since it was shipped from Mexico and not liberated until February 16. This maximum age of a returned banded quail can not be considered the maximum natural life span because of the man-made nature of the

[3] Sumner, E. Lowell, Jr. A life history of the California quail with recommendations for its conservation and management. California Fish and Game, vol. 21, no. 3, pp. 167-256; no. 4, pp. 275-342, 1935.

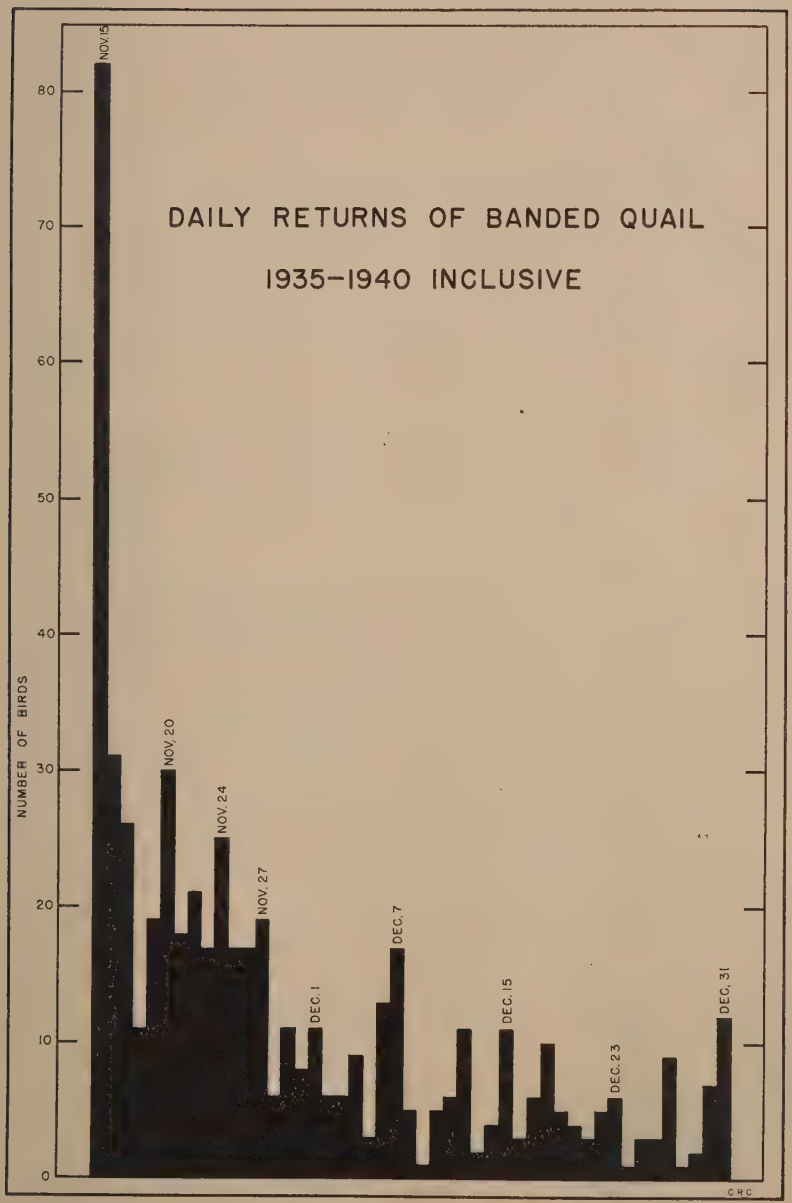


FIG. 66. Time of returns during the hunting seasons of 1935-1940, inclusive. The great variation in heights of columns is caused largely by week-end hunting falling on different dates in different seasons.

death and the unknown age at the time of liberation. However, it may well closely approach the maximum natural age since there is a large number of age returns and the majority of them are from quail which were birds of the year when released (*i.e.*, quail hatched the spring or summer before their liberation). The maximum ages of banding returns undoubtedly approach the natural age limit closer than would maximum ages under captivity because the banded quail live under natural conditions.

The time of band returns or of the taking of banded birds, although not bearing on the period of freedom, is an indication of the distribution of hunting over the hunting season. In figure 66, these times of band returns are plotted. The large number of returns, 15 per cent of the total, for the opening day of the season reflects the heavy hunting on this day. The continued large number of returns during the early part of the season, 77 per cent of the total being from the first half of the season, is of special interest. It might be thought that the distribution of times of returns is conditioned by a relatively great mortality among banded birds especially at the start of the season. This is disproved by the previously discussed evidence on death rates and by the fact that separate tabulations of times of wild-trapped quail returns showed approximately the same distribution as that for farm-raised quail.

**Distances From Points of Liberation**

After the points of liberation and capture of a quail have been located as exactly as possible on a map of known scale, the direct distance between the points can be readily computed with a compass. This has been done in all possible cases but, as already pointed out, 16 per cent of the distance returns could not be used because of insufficient locational data. Besides the inaccuracy due to placing points of liberation and capture, the direct distance can not be considered to be the distance traveled since roundabout wanderings may often intervene between the points of liberation and capture. Nevertheless, the direct distance probably tends to indicate the distance to a new region of establishment as well as showing the minimum and maximum direct distances.

Of the 633 valid distance returns, 53.1 per cent are from within two miles of the point of liberation and are considered as being from the general region of the point of liberation. Actually, decidedly more than 53 per cent of the distances traveled by liberated birds, including those not shot, must be of the general region, as a majority of liberations have been in refuges and quail would have to range as far as several miles to be in open hunting territory. Sumner (1935, p. 211) judges the daily range of quail of his study to be just a few hundred feet but the seasonal range to be as much as two miles or more. It thus seems reasonable that most of these 53.1 per cent of the birds have become established in the general region of liberation although some of them may be ranging in from a more distant point.

Figure 67 shows the major trends in the distance returns of more than two miles. The preponderance of distances of five miles or under, and the sudden drop after the distance of five miles are very noticeable. Apparently about five miles tends to be the limit to the distance traveled

before establishment. The greater variability in distances over five miles bears this out although the fewer returns would also contribute to this variability.

The distances of over about 16 miles are so few and isolated as to be of little significance in a general consideration. They do indicate though that very occasionally quail will travel far probably without becoming adjusted and established. It is likely that there are such birds even in wild populations. Among the distance returns of banded birds several are of distances much greater than 31 miles. These returns generally prove to be undependable in some way (based, for instance, on a loose band found in a yard or a dead bird on the highway). One return of a distance of some 95 miles (from near Escondido to near Glendale) does seem valid, however. This would not be impossible but does seem unlikely especially in view of a period of freedom

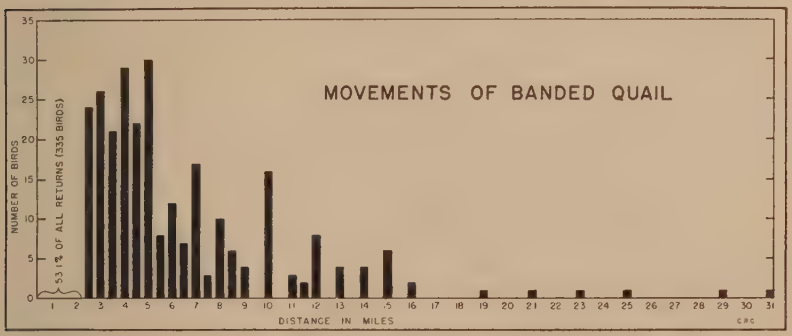


FIG. 67. Direct distances of over two miles from points of liberation. The columns of about ten miles or over should actually appear lower as half miles were not estimated for these longer distances. Distances estimated to be two miles or less are not plotted. To represent the number of these general region returns, it would take five columns of 67 birds each (the five columns for the first two miles, thus making the distance intervals comparable).

of only one month and 26 days. There is some correlation of ages of returns with distance. To determine this the ages of the 31 returns of over 10 miles were plotted. Only 35.5 per cent of these returns were of the first six months whereas 66 per cent of all the age returns are from this period. This would indicate that a few liberated birds tend to continue moving from their point of release well after their first year of freedom.

Trapping records of banded liberated quail, although not numerous, provide some additional data on the distances traveled by released birds. Of 64 records of this type, 14 birds were trapped near water two miles from the point of their liberation while the others were trapped at their point of release. These returns emphasize the tendency for liberated quail to stay in the general region of their liberation.

## Direction or Location of Travel

The distance and direction of travel of liberated quail must be affected by various ecologic conditions including topography, food and cover, but the effect of these is difficult to discern in the present study. A close and continuous follow-up of banded birds would be necessary

for a proper evaluation of these factors. When the points of capture of the quail of a given liberation are plotted on a map, a radiation in many directions from the point of release is shown. This might be expected since liberations are made in areas of suitable quail country. Such spreading and the influence of broader topographic features such as main canyons are shown in figure 68.

Fig. 68. Map of the returns from two liberations of banded quail in Cajalco Canyon below Lake Mathews, Riverside County, California. The liberation near the mouth of the canyon was of 225 quail from August 17-30, 1939. The liberation near the dam was also of 225 birds from September 1-18, 1939. Only the main hills and canyons two or three miles from the points of release are shown. 1939 returns are shown with solid lines and 1940 with dotted.

The two liberations, the returns of which are plotted, were of wild-trapped quail released in country open to hunting. As a result there are more returns for these liberations and they give a truer picture of distances and directions traveled by quail, especially near their point of release. The tendency for most returns to be from the main canyons near liberations undoubtedly is correlated with the presence of water and usually of denser cover and more suitable roosting sites in these canyons. The points of capture should be representative of the released quail because the area shown in figure 68 is well hunted even

beyond the regions of the banding returns and on the hills as well as in the canyons. The figure also illustrates the action of a body of water as a barrier. The region around the edges of Lake Mathews is closed to hunting, however, so it may be that liberated quail spread into this area more than returns indicate.

A few groups of returns give further information on the influence of ecologic conditions. For instance, of 200 quail liberated at Quartz Hill near Palmdale there are six returns, five of which are from the main hills several miles south of isolated Quartz Hill. The travel of these valley quail, then, appears to have been directed by the presence of hills with more suitable ecologic conditions especially of cover and water.

**Establishment**

The liberation of quail often results in better hunting by providing these released birds for shooting, but it would be impossible to release enough birds from season to season to better hunting conditions materially or permanently. The fundamental purpose of the liberation program must be to supply more breeding stock because lasting benefits can only be hoped for in this way. The establishment of liberated quail, implying an adjustment to the ecologic conditions of a certain region and subsequent breeding, thus becomes the all-important question in judging the success of the quail liberating program.

Banding returns can not in themselves adequately answer this question. Direct observation of liberated quail from the time of liberation through the breeding season is necessary. The banding program does afford, however, indications of the degree of success of establishment. The small percentage of returns for the total liberated quail implies that a large number of the liberated birds lives through at least one breeding season. (See previous discussion of life expectation.) These birds would be potential breeders. The information gained from the distances between points of liberation and capture shows that there is a very strong tendency for quail to settle down near their region of release. This is good circumstantial evidence that establishment and consequent breeding has taken place, but is not proof. More direct evidence is provided by one May observation of a banded male quail calling in regular mating fashion from a chosen rock a few hundred yards from the point of release the previous September. More observations of such activity and of actual pairing of banded birds are needed.

Relations between banded and resident quail may be very important since the establishment of released birds is undoubtedly affected by whether they are able to mix with and join resident coveys and subsequently breed with resident individuals or whether antagonism forces them to move farther on to establish themselves. A mixing would be very desirable toward directing the immediate needs of the liberated quail for food, water and shelter. If the liberated quail move off by themselves, they would probably be more exposed to predation and would be less sure of finding adequate food and especially water.

Banding returns again afford circumstantial evidence of the mingling or its lack among released and resident quail. There are seven records of both banded and unbanded birds being shot from the

same covey. These cases are of banded birds shot during the first hunting season after the summer or fall of their liberation and thus are of birds which have had no chance to breed and form family coveys. Undoubtedly much more mingling of released and resident quail takes place than these cases indicate, as only an occasional hunter would think to write in such information. Direct observation of a group of quail for a day and a half after their liberation disclosed about a third of the 150 banded quail staying around the spring where they were released. Several times small groups of banded quail foraged and sought shelter within 50 feet (and as close as 15 feet) of resident quail of the same region, but a true joining of the resident and new birds did not take place. No antagonism was observed and it would seem that such living in the same immediate region would before long lead to the formation of a single covey.

There are many records of two or more banded quail of the same liberation being shot from the same covey or close to the same locality. Of the 78 such records, 43 are of two banded birds from the same covey. These records denote a tendency of released quail to stay together in sizable groups in some known cases, indicating organization and probable adjustment to living conditions. It can not be judged from them, though, to what extent groups of released quail are mixed with resident quail. Furthermore, the distances from points of liberation of group records of banded birds (the majority being the general region but a number being over 10 miles and up to 14) follow about the same distribution as the distances of the returns as a whole. This suggests that the staying together of banded birds does not in itself lead to ready establishment.

During observation of the already mentioned group of 150 liberated quail, approximately two-thirds of the birds stayed in several large groups and definitely left the region of liberation. A group of about 30 of these birds was seen a day and a half after the liberation about a quarter of a mile away. This evidence and that from banding returns is insufficient to say whether released quail tend strongly to become widely dispersed and join with resident quail or stay together and become organized into their own groups. Certainly both types of dispersal or organization do take place.

Even though it seems very likely that a reasonable number of liberated quail becomes established and reproduces, it must be admitted that there is no definite proof of such a successful adjustment. The banding program can not by itself answer the major questions of establishment. An intensive study in which the origin of the released quail, the methods and conditions under which liberations are made, and subsequent relations of birds to all ecologic factors are carefully evaluated, will be necessary.

### Farm-raised Compared to Wild-trapped Quail

Both farm-raised and wild-trapped quail have been liberated in large numbers during the quail banding program. Nevertheless, a comparison of the returns is very difficult because almost without exception farm-raised birds have been liberated in refuges, whereas wild-trapped birds have been liberated in open-hunting territory. (The trapped quail from Mexico constitute a major exception here but

these quail are not comparable to either local wild-trapped or farm-raised birds.) In 1939 in San Diego County, for instance, 588 trapped quail were released in open country whereas 412 raised birds were liberated on refuges. During that year and the next there were 16 returns from the trapped birds but none from the farm-raised quail. In several cases, though, raised quail apparently traveled more and farther than trapped ones. Of 96 trapped quail liberated on the Gavilan Refuge in 1937, there were only two returns and these were of about one and a half miles and four miles distance, whereas of 200 farm-raised quail released the same year and in a similar part of the same refuge there were seven returns and all of these were from distances of over five miles.

The available evidence from banding returns seems to indicate that farm-raised quail do not become established as readily as wild-trapped quail. This might be expected on the basis of the greater adjustment demanded of the former birds. If banding returns are to answer this important question of the establishment of the two classes of quail, liberations must be expressly made at the same point and under conditions as closely comparable as possible.

A comparison of liberations in refuges and in open country will also have to be handled in a carefully controlled manner if the most possible is to be known of the merits of these two types of liberations. As distance returns show, however, a majority of released quail remain in the general region of their liberation. It is thus certain that liberation on a reasonably large refuge affords protection from hunting for a majority of birds. Liberations on small refuges or near refuge edges must cut down this protection as liberated birds tend to radiate out from their point of release. Probably large refuges and liberations two or more miles from their edges are especially desirable for farm-raised birds.

### Returns for Gambel and Mountain Quail

The number of returns for these two species, 36 for Gambel and two for mountain quail, is insufficient on which to base many conclusions. Plottings of distances and of periods of freedom for Gambel quail parallel those for all returns. For instance, 67 per cent of the age returns are from the first year compared to the 72.2 per cent of all the returns, and 50 per cent of the distance returns are of the general region of liberation compared to 53.1 per cent of all returns. The maximum period of freedom of four years and four months for a Gambel quail is near the maximum valley quail time of over four years and nine months. The maximum distance of 21 miles for a Gambel quail is among the several maximum distances for all the returns.

Data are insufficient to discuss establishment with regard to liberated Gambel and mountain quail. Several records may show that Gambel quail tend to stay in or move into flatter country than will valley quail. Comparable liberations involving more Gambel quail will be necessary. When mountain quail and Gambel quail are liberated in regions where these species are not already present, direct observation, especially at waterholes in the hottest time of the year, should prove the most effective means of evaluating the success of liberations.

### Mortality From Sources Other Than Hunting

Approximately 5 per cent of the 755 returns from 1935 through 1940 are due to causes other than hunting. These returns may be listed and briefly commented upon:

33 killed by cyanide fumigation of orange trees. This source of mortality can and probably has been done away with to a large extent.

4 found dead. The cause of such deaths can not be ascertained but is likely to be either disease or starvation.

3 killed by cats.

2 flew into telephone wires.

1 flew into wire fence.

1 flew into car.

1 sick bird not shot.

1 with large growth on eye, blind, captured by cat.

1 caught in gopher trap.

1 caught in squirrel trap.

With the exception of mortality due to fumigation, the several deaths due to sickness or the inability of domesticated birds to adapt themselves even though food may be plentiful may indicate a serious loss in released game-farm reared birds, disproportionate to similar losses in wild populations. The loss from cats, too, may be serious especially since it can be assumed that most of the quail killed by these predators are not brought into homes.

### Summary and Conclusions

The outstanding points definitely shown by this study of the quail banding returns from southern California for the years 1935 through 1940 may be listed:

There are returns for 2.04 per cent of the 65,000 quail banded and liberated in southern California from 1932 through 1940.

The maximum percentage of returns for birds released any one year is 3.92 per cent.

Relatively few returns from releases during a previous closed hunting season indicate a high natural mortality.

Seventy-two and two-tenths per cent of the returns are from quail released six months or less before the time of their capture.

Maximum period of freedom recorded for a banded quail was four years, nine months and 10 days.

Distribution of ages of returns strikingly confirms Sumner's (1935) estimates of the high natural death rate.

Concentration of hunting during the early part of the hunting season is shown by the fact that 77 per cent of the dated hunting returns are from the first half of the season.

Of the valid direct distances of returns from points of liberations, at least 53 per cent are of two miles or less.

Maximum dependable distance of a return is 31 miles.

Spreading of quail from their point of release is typically in many directions but guided, for instance, by major canyons or various other ecologic conditions.

Banding returns do not prove establishment and breeding of liberated quail but do strongly indicate it, especially in that the majority of the returns are from the general region of release, and many returns show that banded birds have stayed together or have mixed with resident quail.

Farm-raised quail tend at times to move farther from their points of release than do wild-trapped birds, probably reflecting less ready adjustment.

Liberations on refuges are effective in protecting most of the liberated birds if the liberations can be made a mile or more from the edges of the refuges.

Only 5 per cent of the returns are from sources other than hunting.

Other conclusions, chiefly in the nature of suggestions since the evidence by its very nature is often suggestive but not conclusive, can be drawn from this study. These conclusions consider especially how the quail banding and liberating program can best be managed in the future.

Hunters turning in bands might well be asked for information as to whether banded birds were from the same covey or were in coveys with unbanded birds. The request for this information could be inserted on the cards now in use.

In studying liberations of particular importance, oral interviews with those people who turn in bands might prove very worthwhile and would be necessary for accuracy in placing points of capture.

The best time for liberations, especially in view of the very high natural mortality during the first year and the mortality due to hunting, is very likely in January. It is not as convenient in various ways to hold quail until this time but the greater potential breeding stock should justify it.

Liberations should probably be of large numbers of quail, say 100 or more, since groups are then more readily formed as birds spread out from their point of liberation.

Liberations should be made, as has been the rule, in good quail country. The presence of adequate cover and water should be especially considered.

If, as seems very likely, it is desirable for quail to stay more or less together and remain unexcited when liberated, liberations should be made very slowly and quietly after placing the crates in dense cover and leaving them unopened for at least 15 minutes.

Direct observation of banded quail and careful control of conditions of liberations will be necessary to answer definitely the question of establishment and breeding.

Refuges, if they are to afford the desired protection to liberated quail, should have good localities for liberations, at least a mile and preferably more from any edges of the refuge. Many present refuges are not large enough or shaped properly for such liberations. It would seem that large rectangular refuges, very possibly of a temporary or shifting type, would be most effective for allowing liberated quail to multiply.

# DEVELOPMENT OF STEELHEAD TROUT EGGS[1]

*By* J. H. WALES
*Bureau of Fish Conservation*
*California Division of Fish and Game*

The care of eggs in hatcheries is such an important part of trout culture it might seem extraordinary that we know so little about the eggs and their development. It is hoped that the information and illustrations presented in this paper may aid both the practical hatcheryman and the student of trout embryology toward a better understanding of this phase of fish culture.

The original observations included herein concern the steelhead (*Salmo gairdnerii gairdnerii*). It is hoped that similar observations may be made by investigators on other species of trout so that we may eventually arrive at a better understanding of trout embryology and the variations which probably exist among the several species. If such an understanding will improve trout production in the hatcheries and aid the biologist in trout fisheries management, then such studies as these have served their purpose.

The writer wishes to acknowledge the aid of Mr. A. C. Taft, Chief of the Bureau of Fish Conservation, at whose request this study was made.

The egg samples and the temperature data for this paper were secured at the Big Creek Hatchery of the California Division of Fish and Game, which was until recently located near the coast about 70 miles south of San Francisco.

Egg samples were taken daily. These were at first preserved in formalin. After two weeks it was found that they shrank too much, and thereafter they were placed in Bouin's fluid. The early formalin eggs were then discarded as unsuitable for study and were replaced by Bouin-preserved eggs of another female steelhead. The egg samples for the first two weeks were thus from a different female than the remainder, but this does not change the features of this study in any practical way.

The temperature record, made during the incubation period, was obtained from the graph made by an automatic recording thermometer. By taking the hourly temperatures and averaging them we obtained an accurate figure for each day.

For many years temperature units were used by hatcherymen in estimating the length of time required for trout eggs to develop, and it was believed that the total number of units was constant for any species regardless of the average temperature throughout the incubation period.[2] In 1934, however, Embody[3] demonstrated that this was

[1] Submitted for publication, May, 1941.

[2] A temperature unit (T.U.) is a temperature of one degree Fahrenheit above freezing (32° F.) for a period of one day. For example, in this experiment the average water temperature for the first day was 55.9° F., thus constituting 23.9 T.U. (55.9° minus 32°). The second day the temperature averaged 52° F., making 20 more T.U., or a total of 43.9 T.U. to the end of the second day.

[3] Embody, G. C. Relation of temperature to the incubation periods of eggs of four species of trout. American Fisheries Society. Transactions, 64. meet., 1934, pp. 281-291.

not the case and gave much useful data of his own. Table 1 has been made up from these data and shows how great are the variations in temperature units at different water temperatures. From it, it appears that temperature units are not a safe measure for the trout culturist. For that reason they are not shown on the graph in figure 69 of this paper, but they are included in the section on the description of daily egg samples and in the drawings, for the benefit of those who are accustomed to thinking in such terms.

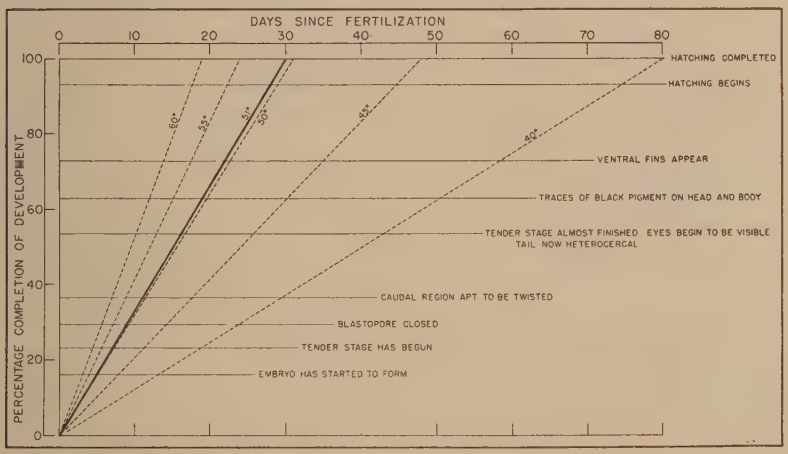


FIG. 69. Number of days required to bring steelhead eggs to different stages of development at various temperatures. The 51° data based on experiments by J. H. Wales. Data for development at other temperatures are hypothetical: total incubating periods are based on Embody's (1934) tables; percentages of development based on the assumption that the earlier developmental stages are in straight-line relationship to the total incubation periods at the various temperatures.

In any species of trout, the incubation period or average hatching time of the eggs is not immutably fixed for a given temperature but may vary as much as six days between egg lots taken from different parent fish. However, our figure for the number of days required to hatch the steelhead eggs considered in this study was almost identical with that of Embody's for rainbow trout at the same average temperature. (See table 1.)

The time from the hatching of the first to the hatching of the last egg in any lot may be only two days or it may be drawn out to cover two weeks, depending upon the temperature of the water and upon the strain of fish. When the water temperature has been constantly warm throughout development the hatch will be rapid. Wild trout tend to produce eggs which are more alike in speed of development whereas in cross-bred strains there will naturally be more variation in the time required for hatching.

Harlan Cheyne[4] has recently shown that dog salmon eggs will develop at approximately the same speed in waters with oxygen levels lying between 4 and 7.84 P.P.M. It might seem reasonable to suppose, therefore, that oxygen does not play a significant role in determining the rate of development in average hatchery waters.

[4] Washington State Pollution Laboratory, Gig Harbor, Washington.

TABLE 1

Number of Days and Temperature Units Required for Trout Eggs to Hatch

| Water temperature | Rainbow | | Brown | | Brook | | Lake | |
|---|---|---|---|---|---|---|---|---|
| | Number days to hatch | Temperature units | Number days to hatch | Temperature units | Number days to hatch | Temperature units | Number days to hatch | Temperature units |
| 35° F. | | | 156 | 468 | 144 | 432 | 162 | 486 |
| 40° F. | 80 | 640 | 100 | 800 | 103 | 824 | 108 | 864 |
| 45° F. | 48 | 624 | 64 | 832 | 68 | 884 | 72 | 936 |
| 50° F. | 31 | 558 | 41 | 738 | 44 | 799 | 49 | 882 |
| 55° F. | 24 | 552 | | | 35 | 805 | | |
| 60° F. | 19 | 532 | | | | | | |

Spaces without figures indicate incomplete data rather than a proved incapability of eggs to hatch at those temperatures.

NOTE: These figures are based on Embody's paper (1934). For greater convenience, his Centigrade temperatures have been converted into Fahrenheit, and his fractional figures changed to the nearest whole numbers. Temperature units are not given by him; they have been calculated for the above table to show the variations in temperature units at different water temperatures.

The "tender period," or that stage in the development of trout eggs when the embryo is easily injured by mechanical shock, is of importance to fish culturists and is indicated in the descriptions of the daily samples and in figure 69. However, the eggs become tender very gradually and they leave the tender period gradually so it is not a simple matter to set exact limits for this interval. It is reasonable to assume from table 1 that the brown, brook and lake trout eggs take longer to reach the tender period than the rainbow and steelhead, and that the lake trout eggs take longer than the brook and the brook longer than the brown.

Before giving a description of the daily egg samples it must be pointed out again that while this study is restricted to sea-run steelhead eggs it may also apply fairly well to other strains of the rainbow-steelhead group. The progress of development at the observed average temperature of 51° F. is depicted by the solid line in figure 69. There is no experimental evidence at present to show whether or not development at other temperatures proceeds at a proportional rate. Purely for the sake of providing some kind of guidance to the fish culturist, it has been assumed that such is the case, and the broken lines in the figure have been drawn on this basis. It must not be forgotten that they are theoretical and that future observation may prove them to be more or less inapplicable. They would in that case have to be discarded from the graph, but that fact would in no way affect the validity of the observations made at 51° and the solid line which represents them. As for other species of trout, table 1 shows that their development is not in harmony with the steelhead even when the average hatching temperature is 51°.

During the first four days of steelhead development at 51° F. average temperature, the foundation of the embryo is being laid but it is not until the fifth day that a recognizable embryo can be seen. (See Fig. 72.) From the fifth to the twelfth day the changes in the appearance of the embryo are very rapid. The rate of development is not actually faster but during this period the embryo is taking on the appearances of a fish whereas after the twelfth day has been reached, the embryo fish increases in size and in many details which are not so apparent. By the ninth day the blastopore is closed and on the thir-

teenth day the full quota of sixty body segments or somites have been acquired. The tender period would ordinarily be considered that which extends from about the seventh to the sixteenth day in the eggs under observation, although this is a point on which hatchery men do not all agree. The eyes have become pigmented, at 51° F., by the sixteenth day, and the eggs can be "addled" and shipped, but there may be some advantage in waiting another day or two until the embryos are stronger. In the group of steelhead eggs being considered, the hatching began on the twenty-eighth day and was completed on the thirtieth.

### Description of Daily Egg Samples

In the following descriptions a few of the more important facts have been given for each of the daily egg samples. These samples were taken at the same time each day and the temperature units listed refer to the total accumulated up to the time that particular sample was taken.

| Number of Days Since Fertilization at Average Temperature of 51° F. | Temperature Units | |
|---|---|---|
| 1 | 23.9 | Blastodisc without cell division. (See Fig. 70.) |
| 2 | 43.9 | Blastodisc has rounded up and is slightly smaller in diameter; it is composed of three layers of cells. (See Fig. 71.) |
| 3 | 62.2 | Blastodisc slightly larger; cells about 1/5 the size of those in sample 2. |
| 4 | 81.1 | Blastodisc slightly larger; cells about 2/3 the size of those in sample 3. |
| 5 | 98.4 | Blastodisc slightly larger; edge thickened; embryo started to form. (See Fig. 72.) |
| 6 | 117.0 | Thickened edge of blastoderm is narrower; embryo with thickenings. (See Fig. 73.) |
| 7 | 134.4 | Blastoderm covering about 3/8 of the yolk surface; embryo much lengthened and thickened, strongly contrasted against the yolk; eggs are now tender and should not be handled roughly. (See Fig. 74.) |
| 8 | 157.5 | Optic vesicles forming; body with 23 somites; blastoderm covering about 3/4 of the yolk. (See Fig. 75.) |
| 9 | 174.5 | Blastopore closed; optic vesicles have invaginated; notochord continuous with brain. (See Fig. 76.) |
| 10 | 195.4 | Eye lenses well developed; 32 somites present; otic vesicles starting to form; notochord continuous with brain. (See Fig. 77.) |
| 11 | 216.6 | Cerebral hemispheres evident; segmentation of hind brain begun; 46 somites present; pectoral fins starting to form; notochord ending just anterior to otic capsules; the caudal region apt to be twisted. (See Fig. 78.) |

| Number of Days Since Fertilization at Average Temperature of 51° F. | Temperature Units | |
|---|---|---|
| 12 | 236.8 | Optic lobes starting to grow over interior-posterior margin of eyes; lenses not quite broken away from ectoderm; notochord ending just posterior to anterior end of otic capsules; 49 somites present, the last 5 have not become myomeres; the embryo covers about 3/8 circumference of egg. |
| 13 | 255.8 | Lenses have broken away from the ectoderm; 60 somites present, all have become myomeres; 3 gill buds present. (See Fig. 79.) |
| 14 | 273.2 | Fin folds about half as wide as body; tail still homocercal; mouth and gill cartilages faintly evident. (See Fig. 80.) |
| 15 | 297.8 | Tail becoming heterocercal; eyes becoming pigmented. |
| 16 | 315.9 | Four gill buds evident at sides of throat; hereafter there are but slight changes in the brain, the hind brain apparently decreases and the cerebral hemispheres enlarge; anal fin first noticeable here, the eggs are past the tender period and can be handled more roughly. (See Figs. 81 and 82.) |
| 17 | 336.6 | No apparent changes except in size. |
| 18 | 357.4 | Dorsal fin begins here as a faint thickening; nostrils first evident; gill slits on ventral side extending almost to midline. (See Fig. 83.) |
| 19 | 377.7 | Opercle grown back over first gill bar; traces of melanophores on head and body. |
| 20 | 395.3 | Gill bars have become definite arches; mandible has become pointed up between eyes but still far from maxillary. |
| 21 | 412.0 | Increase in size. |
| 22 | 430.8 | Ventral fins now evident. |
| 23 | 448.0 | Cerebral hemispheres about 2/5 length of optic lobes. |
| 24 | 466.6 | No apparent changes. |
| 25 | 485.4 | Point of opercle extending back to fourth gill arch, only the distal ends of last 3 exposed. |
| 26 | 500.4 | No apparent changes. (See Fig. 84.) |

| Number of Days Since Fertilization at Average Temperature of 51° F. | Temperature Units | |
|---|---|---|
| 27 | 518.7 | Mandible apparently stops its forward growth at this stage. |
| 28 | 535.9 | Dorsal and anal fin rays first visible at this age; point of opercle entirely covering first 2 gill arches; hatching begins. |
| 29 | 556.1 | Length of embryo equal to circumference of egg; anal fin shows about 8 rays and dorsal fin shows about 6. |
| 30 | 573.9 | Hatching completed. (See Fig. 85.) |

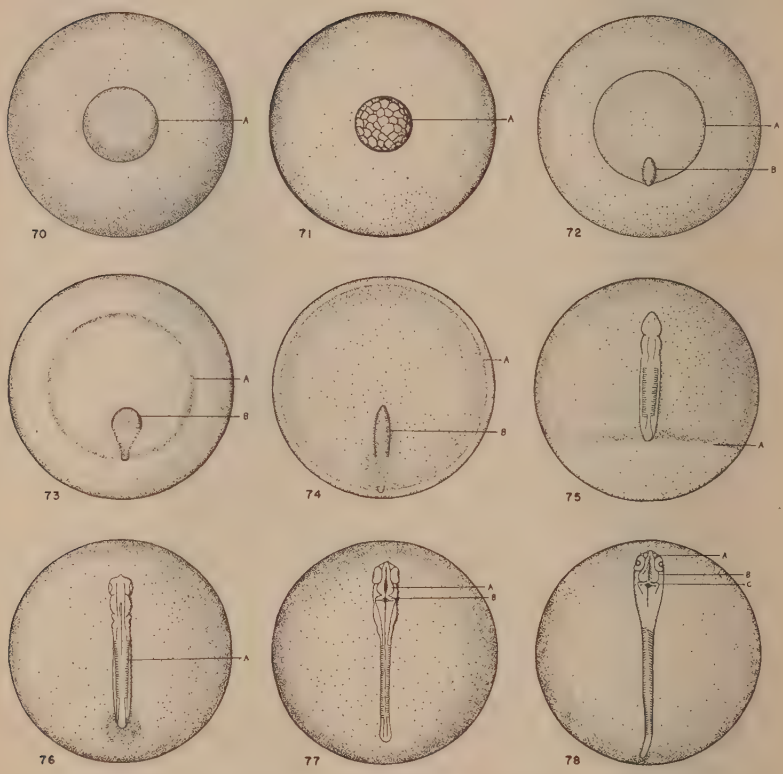


FIG. 70. One day after fertilization, at average temperature of 55.9° F. (23.9 T.U.). A: Germinal disc.

FIG. 71. Two days after fertilization, at average temperature of 53.9° F. (43.9 T.U.). A: Blastodisc.

FIG. 72. Five days after fertilization, at average temperature of 51.7° F. (98.4 T.U.). A: Edge of blastodisc. B: Embryo.

FIG. 73. Six days after fertilization, at average temperature of 51.5° F. (117.0 T.U.). A: Thickened edge of blastoderm. B: Embryo.

FIG. 74. Seven days after fertilization, at average temperature of 51.2° F. (134.4 T.U.). A: Edge of blastoderm. B: Embryo.

FIG. 75. Eight days after fertilization, at average temperature of 51.7° F. (157.5 T.U.). A: Lip of blastopore.

FIG. 76. Nine days after fertilization, at average temperature of 51.4° F. (174.5 T.U.). A: Somite.

FIG. 77. Ten days after fertilization, at average temperature of 51.5° F. (195.4 T.U.). A: Future optic lobe. B: Hind brain.

FIG. 78. Eleven days after fertilization, at average temperature of 51.7° F. (216.6 T.U.). A: Olfactory capsule. B: Future optic lobe. C: Hind brain.

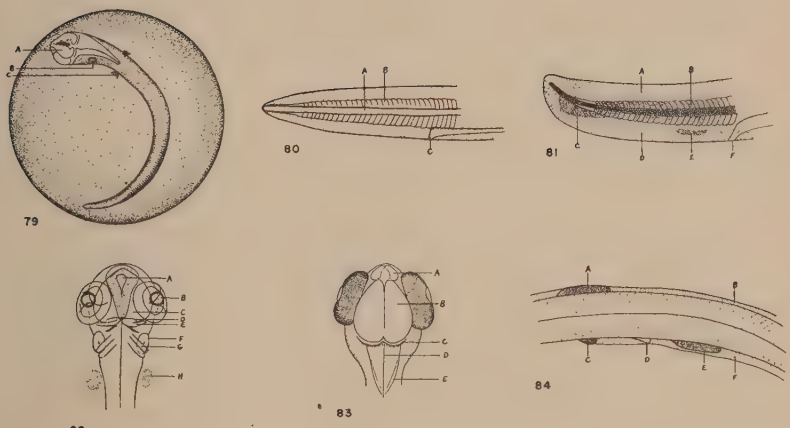


FIG. 79. Thirteen days after fertilization, at average temperature of 51.7° F. (225.8 T.U.). A: Optic lobe. B: Otic capsule. C: Future pectoral fin.

FIG. 80. Fourteen days after fertilization, at average temperature of 51.5° F. (273.2 T.U.). A: Notochord. B: Myomere. C: Vent.

FIG. 81. Sixteen days after fertilization, at average temperature of 51.7° F. (315.9 T.U.). A: Dorsal fin fold. B: Myomere. C: Future caudal fin. D: Anal fin fold. E: Future anal fin. F: Vent.

FIG. 82. Sixteen days after fertilization, at average temperature of 51.7° F. (315.9 T.U.). Ventral view of head showing: A: Third ventricle. B: Lens of eye. C: Optic lobe. D: Edge of mandible. E: Hind brain. F: Otic capsule. G: Gill bar. H: Future pectoral fin.

FIG. 83. Eighteen days after fertilization, at average temperature of 51.8° F. (357.4 T.U.). A: Cerebral hemisphere. B: Optic lobe. C: Hind brain. D: Future fourth ventricle. E: Future cerebellum.

FIG. 84. Twenty-six days after fertilization, at average temperature of 51.2° F. (500.4 T.U.). A: Dorsal fin. B: Dorsal fin fold. C: Ventral fin. D: Vent. E: Anal fin. F: Anal fin fold.

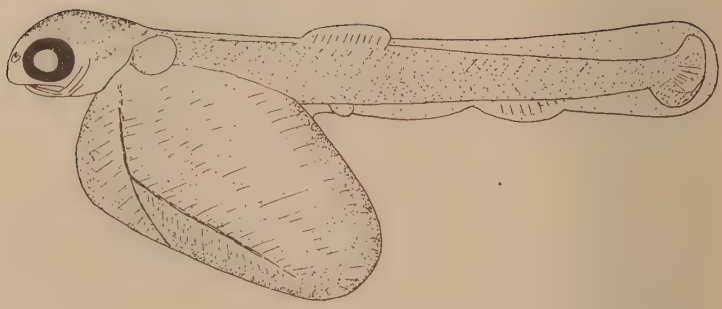

FIG. 85. Hatched fry. Thirty days after fertilization, at average temperature of 51.1° F. (573.9 T.U.).

## Glossary

Blastoderm: The foundation from which the embryo will form. For practical purposes the blastoderm is the same as the blastodisc or germinal disc. (See Figs. 70 and 71.)

Blastodisc: *See* blastoderm.

Blastopore: As the blastoderm grows over the egg it finally leaves a circular opening or blastopore. (See Fig. 75.)

Bouin's fluid: A mixture of 75 parts saturated picric acid, aqueous solution; 25 parts formalin (40 per cent formaldehyde); and 5 parts glacial acetic acid. This is widely used for preserving biological material.

Capsule: An embryonic pouch, usually of cartilage, from which an organ will develop.

Cartilage: A substance more flexible than bone but serving the same purpose. A trout's skeleton is at first all cartilage but later part of it changes to bone.

Cell: A microscopic brick in the structure of the body of the fish. Each cell is surrounded by a membrane and has a nucleus and other distinctive features but in one part of the body the cells may be quite different from those in another part. For example, the cells in the skin of the fish look much different from those in the liver.

Cerebral hemispheres: These are the front lobes of the trout's brain.

Cerebellum: A single lobe of the brain situated at the top and rear.

Distal: The remote or extreme end of a structure.

Ectoderm: The outer layer of cells which give rise to various organs as the embryo develops.

Egg: An ovum which when fertilized may develop into an animal.

Embryo: A trout embryo results from a fertilized egg and hatches into a fry.

Fin fold: The dorsal and anal fins form in certain areas of the ridges which develop along the dorsal and ventral margins of the embryo. These ridges are the fin folds.

Gill arch: The cartilage which supports the gill filaments. The trout has four on each side of its head.

Gill bud: The first indications of the future gills are called gill buds.

Heterocercal: The tail of a fish is heterocercal when the upper and lower lobes are not of the same length. In figure 81 the upper lobe is longer.

Homocercal: The tail of a fish is homocercal when the lobes are equal in length as in an adult trout or when the tail is pointed as in figure 80.

Invaginate: To fold in as when a rubber ball is pushed in at one point.

Mandible: The lower jaw.

Maxillary: The upper jaw.

Melanophore: Black pigment cells. Large numbers of these give trout their dark color.

Membrane: A thin "skin."

Myomere: An embryonic muscular segment which later becomes a section of the side muscle of a trout.

Notochord: The embryonic rod around which the vertebral column forms.

Optic: Referring to the eye. For example the optic lobes of the brain which are connected to and control the eyes.

Otic: Referring to the ear. For example the otic capsules are the cartilaginous coverings for the future elements of the internal ears.

Somite: A segment of the embryo's body which will later form one of the side muscles. A somite is an early stage in the formation of a myomere.

Ventricle: One of several natural cavities in the brain.

Vesicle: A pouch or sac. For example an optic vesicle is an embryonic eye.

Yolk: The food part of an egg.

# PRICES OF SEA OTTER PELTS [1]

*By* Edna M. Fisher
*San Francisco State College*

The appearance of a large herd of sea otters close to the shore and not far south of Carmel, California, in the spring of 1938 caused much excitement both far and wide. Since the sea otter possesses the most beautiful as well as the most valuable fur known, and since they are rare animals today, the result was that this herd soon was being valued for their pelts and at the most fabulous prices. Verbally and in print the figures soared to all levels and there seemed to be no limit. Such rumors, coupled with the closeness of the otters to the beach line, were such that some unwise person might be sorely tempted to try to collect for himself one or two otter and thus be badly deluded into thinking that he had made a small fortune in a very short time. Thanks to the special care taken by the California Division of Fish and Game such a tragic event did not occur, nor has to date.

Now that the greatest wave of excitement has passed and all seemed to be normal, it was naturally assumed that most if not all of the rumors about high prices would disappear. Such good luck seems to be far from true, for recently more rumors have been brought to the writer's attention. Considering all things, it seems to be worth while at this time to present briefly a few of the data on hand concerning the prices paid for sea otter pelts. Also it seems desirable to end if possible some if not all of the current rumors concerning the unbelievably high prices of sea otter skins.

At the time of Bering and soon after the discovery of the sea otter, the pelts sold for 20 rubles each in Kamchatka, 30 in Yakutsk, 40 and 50 in Irkutsk, and if taken to the Chinese frontier for direct sale the price was as much as 80 to 100 rubles per skin. A ruble was worth approximately 50 cents.

William Coxe reported in 1780 (p. 13) that sea otter skins sold in Kamchatka for 30 to 40 rubles apiece for the first grade, 20 to 30 rubles for the second grade, and 15 to 25 rubles for the third grade or the very worst of the skins. If the pelts were taken inland to Kiakhta and sold directly to the Chinese merchants the returns were much greater. At this Chinese frontier market, the first and second grade skins would bring 80 to 140 rubles whereas the worst or third grade would bring as much as 30 to 40 rubles.

Some furs, evidently collected by the Hudson's Bay Company, were brought from England to St. Petersburg and sold, and some of these were later resold to the Chinese at Kiakhta. According to Coxe (p. 235) some 29,932 skins came from England to St. Petersburg from 1775 through 1777 and the best of these were valued from 90 to 100 rubles apiece and the poorest quality at 60 to 80 rubles.

[1] Submitted for publication, August, 1941.

In 1786 Captain Hanna (Portlock and Dixon, 1789, p. 315) sold the pelts he had collected in the markets of Canton, China. For 140 first grade pelts he received $60 per skin, 172 second grade skins at $45 each, 80 skins of the third grade at $30 each, 55 fourth grade skins at $15, 50 skins of the fifth and lowest grade at $10 each. Captain John Meares (*ibid.*, p. 319) had a little better luck in 1786 and obtained higher prices than did Captain Hanna. Captain Meares also sold his cargo of skins in Canton and received the following prices: 50 prime skins at $91 each, 50 prime at $70 each, 52 second grade at $50 each, 58 third grade at $35, 31 fourth grade and somewhat worn at $20 each, 50 fifth grade and much worn at $15, 26 old and very bad skins at $5, 12 large pieces with flips at $10 each, 17 small pieces with flips at $5 each, 37 tails at $2, and 31 tails of inferior quality at $1.30 each. In 1787 Captain Hanna sold 604 skins averaging $40 each. Captain Berkeley sold his collection of 800 superior skins for $30,000 or an average of $37.50 each.

M. de la Peyrouse, the famous Frenchman who visited the Pacific Coast in 1786, reported sea otter fur prices high in Kamchatka and worth 30 rubles in St. Pete and St. Paul. But along the California Coast, according to his methods of figuring prices, the largest skins were worth 30 piastres, the Spanish at Monterey would value the same skin at 45 piastres, and according to Captain Cook's way of evaluating such a skin would be worth 60 piastres. This last price, de la Peyrouse thought to be unreasonably high.

In 1808 the prices of sea otter pelts were still on the decline. In this year Captain William Smith sold his collection of good sea otter pelts for $30 to $40 in the Chinese markets. Although this was somewhat of a drop in price the captain invested the proceeds in tea, spices and silks and returned to Boston. In Boston the profits made from the sale of his cargo were exceptionally high and were more than enough to make the entire trip very much worth while.

Before the Russian and American merchants had made the Spanish conscious of the values of the fur of the sea otter, this animal had had very little value to the Spanish and little more to the local Indians. According to Bancroft (1884, vol. 1, p. 440) a sea otter skin was not worth more than two rabbit skins; such a low value did not tempt the Spanish to use them or send any to Mexico.

During the period when the Spanish Government was trying to compete in the sea otter fur trade with the more efficient Russians and the extremely energetic Bostonians, the sea otter pelts were collected by the Mission padres and brought to Monterey. The price paid in Monterey was $40 for the finest pelts and less for the poorer grades. These furs were shipped to Mexico and from there to Canton. The poor technique of the local Indians and their lack of interest combined with inefficient government routines made the fur business a losing enterprise against the stiff competition of the Russian and American hunters and merchants.

General Vallejo, who had extensive holdings on the northern shores of San Francisco Bay, had found a small herd of sea otter in the bay off Sonoma Creek, and to these he gave what protection he could. But in 1847 some hunters from the Santa Barbara region came into the bay and slaughtered all 42 animals of the herd. This was the last of

the sea otters known to occur in San Francisco Bay. The pelts were sold in San Francisco for $60 each.

The prices paid for sea otter skins reached a low level during the first part of the nineteenth century. About 1840 Sir James Douglas (p. 8) reported that otter skins were worth $15 on the Chinese frontiers where the highest prices were paid. Bancroft (vol. 2, p. 316) mentions one instance where the trade-in price of sea otter pelts was fixed at the surprisingly low figure of $8 for the largest skins. This is one of the lowest if not the lowest price (of which there is a record) for a first grade large skin.

In 1869 Thomas Taylor (1898) reported that sea otter skins were selling for $20 (gold) apiece. He had obtained some and was dissatisfied with $20 as a price and even with the $40 to $60 that he might get in the San Francisco market at the time. He packed up his furs and shipped them off to Europe to the Leipzig market in hopes of still higher prices. He was not so lucky in this venture for he received on the average only $30 a skin at Leipzig, and no doubt had to pay all the shipping expenses to send the furs over there. How much better off he would have been to have sold his collections in San Francisco! He also reported that the prices paid for the fur catch of 1869 were on the decline over those of the preceding year. He said that $25 was considered a high price to pay for a skin in San Francisco. London was paying on an average of 175 shillings the same year. In the meantime the trader, forced by the stiff competition, was receiving the worst of the deal—he was paying almost as much to the hunter for the skins as he could get for them in the fur markets.

In 1873 there seemed to be a slight rise in prices. In this year Elliott (1875, p. 51) reported that 3,000 sea otter skins were sold at an average price of $75. In 1880 skins were worth $2.50 to $110 each according to size and quality. Rogers (quoted by Elliott, 1887, p. 487) stated that 75 skins of the California sea otter were sold in 1880 and averaged $50 each. In 1887 Elliott (p. 484) reported that a northern sea otter skin was worth $150, an average skin of good quality $100, and an exceptionally fine skin was worth $350.

In 1888 the prices of sea otter pelts continued to rise. In the London market, which had become the best market for such skins, the average price was 21 pounds or roughly $105 each. In 1889 the average price was 33 pounds ($165), a marked increase. Each year from now on there were fewer skins on the market and accordingly a rapid increase in prices. In 1891 the average price was 57 pounds ($285) and in 1903 the prices ranged from 88 pounds ($440) to 200 pounds ($1,000), and for the extra rich large skins as high as 225 pounds ($1,125).

Seton (1926, p. 402, quoting Taylor) states that in 1910 at the London market $1,703.33 was paid for a sea otter skin. In 1916 one pelt of the Alaskan species was sold by the United States Government for $500, in 1917 two Alaskan sea otter were sold for $689.70 and in 1918 the Government offered one which was sold for $150. Yet Taylor said that the fur boom of 1920 caused the price to soar to $2,000 and $2,500 a skin. In 1923 Evermann (p. 109) gave the price of sea otter pelts as $2,000 to $3,000 each; but so far it has been impossible to find the source of information used by Evermann in order to verify these

figures. *If* such high prices were paid it was not in the American markets but probably in the London market.

The few pelts which are sold in the market today do not bring such fabulous prices as those mentioned immediately above. The sea otter are now legally protected by the United States Government as well as by each State along whose coasts they occur.

As a result of the strict enforcement of the law, the sea otter is showing a slow increase in numbers in all parts of its range. At some time in the distant future the Government may be able to select a few of the extra males each year and sell the furs for the benefit of the Government as is now done in the case of the northern fur seal. The Japanese Government systematically captures a certain number of sea otters each year in the Kuriles and these furs are sold at auction for the benefit of the State. The darkest and largest skins bring the best prices, 500 to 600 pounds apiece, according to Bergman (1929, pp. 28, 29) who visited these islands and saw the sea otter skins so collected.

The following table shows the range of the prices *actually* paid for Alaskan sea otter skins for the 16-year period, 1924 to 1940. These were confiscated skins sold by the United States Government at public auctions unless otherwise noted. The writer is greatly indebted to Mr. Seton H. Thompson of the United States Fish and Wildlife Service, who so kindly supplied most of the data presented in this table. As can be seen, thousand-dollar pelts are nonexistent and the incentive to poachers is not what the feature writers would lead us to believe.

**Confiscated Sea Otter Skins Sold at Public Auction for Account of U. S. Government 1924-1940**

| *Sale date* | *No. of skins* | *Price each* |
|---|---|---|
| October 15, 1924 | 4 | $300, $295, $270, $155 |
| May 25, 1925 | 2 | $205, $190 |
| October 3, 1927 | 2 | $62, $30 |
| September 30, 1929 | 5 | $450, $300, 3 at $71 |
| October 19, 1931 | 2 | $370, $60 |
| May 15, 1933 | 12 | $465, $305, $255, 2 at $245, $185, $170, $140, $110, $75, 2 at $12 |
| October 15, 1934 | 1 | $3 (pup skin) |
| April 8, 1935 | 1 | $300 |
| September 16, 1935 | 3 | $105, $50, $40 |
| April 27, 1936 | 1 | $310 |
| September 14, 1936 | 3 | $125, $85, $6.50 |
| April 19, 1937 | 12 | $410, $150, $140, $105, $60, 3 at $20, 2 pup skins at $3, 2 at $1 |
| October 2, 1939 | 1 | $125 |
| September 9, 1940 | 2 | $73, $54 |
| September 16, 1935 | 1 | $350 (not the U. S. Government) |
| May 2, 1938 | 1 | $88 (not the U. S. Government) |
| October 10, 1938 | 1 | $255 (not the U. S. Government) |
| May 22, 1939 | 10 | withdrawn (Japanese Government) |

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# Editorials and Notes

## TWENTY-FIVE YEARS AGO IN "CALIFORNIA FISH AND GAME"

In the October, 1916 issue of "California Fish and Game," Dr. Harold Heath presented an interesting article on the clams of California and their conservation. He urged more stringent regulations on the taking of the more popular species and recommended a greater utilization of the less known kinds. Since this was written, some of the species he mentions have become much scarcer in spite of improved protection.

C. H. Kennedy wrote a paper on the desert top minnow (*Cyprinodon macularius*) and urged that it be used as a mosquito control fish throughout the State. The so-called mosquito fish (*Gambusia*) has since been found to be an adaptable mosquito control and is now found everywhere. However, the more colorful *Cyprinodon* would probably be equally useful and certainly more attractive.

An account of hunting and fishing conditions in San Mateo County in 1916 was contributed by J. S. Hunter. This county still contains much wild country in spite of its proximity to metropolitan centers and it provides good hunting and fishing—though not as good as 25 years ago. E. B. Ralston reminisced of quail hunting in the San Mateo hills in the 1860's when hunting was almost too good to be true. He told of ground-sluicing 192 quail in seven shots one day and of wing-shooting 106 birds in 129 shots on another occasion.

The short notes and articles covered a wide variety of subjects from abalone pearls to fish hatchery production, from coyote predation to forest fires. Progress on the construction of the now famous Mt. Whitney Hatchery was described. There was a discussion of the then infant tuna canning industry and a note on the ever-controversial Humboldt County crab fishery.

On the back cover of the 1916 issue was an abstract of the game laws then in force. This abstract is reproduced herewith, with the old district numbers replaced by numbers roughly corresponding to present districts.

Differences and similarities with present laws can be noted. Deer regulations are not greatly different now. Forked horns are protected in District $1\frac{3}{4}$ and the season limit is one buck in Districts $1\frac{3}{4}$ and $4\frac{1}{2}$. In much of the State the season is almost the same, and in some districts it is somewhat shorter. The present rabbit season is shorter in northern and central California and longer in the south. Tree squirrels are now given complete protection. Elk, mountain sheep and sea otter are still on the protected list, but a limited open season for antelope is planned for 1942, the first in many years. Seasons and bag limits on ducks, geese, brant and mudhens have been drastically curtailed and certain species of ducks and geese are given full protec-

**ABSTRACT OF GAME LAWS (Sporting), 1916**

| Variety | District | Open season (both dates included) | Bag limits, etc. |
|---|---|---|---|
| DEER | 1, 1½, 1¾, 4½, 23 | Aug. 15 to Oct. 14 | No does, fawns or spike bucks; no sale of meat. |
| | 2, 3 | Aug. 1 to Sept. 14 | Two bucks per season |
| | 3½, 4, 4⅛, 4¾ | Sept. 1 to Sept. 30 | |
| RABBITS (Cottontail and Brush) | All | Oct. 15 to Dec. 31 | 15 per day, 30 per week |
| TREE SQUIRRELS | All | Sept. 1 to Dec. 31 | 12 per season |
| ELK, ANTELOPE, MOUNTAIN SHEEP | All | No open season | Killing of elk a felony |
| SEA OTTER | All | No open season | Penalty, $1,000.00 fine |
| DUCKS, GEESE, BRANT, MUDHENS | All | Oct. 15 to Jan. 31 | Ducks and geese, 25 per day, 50 per week; honkers and sea brant, 12 per day, 24 per week |
| WILSON SNIPE, BLACK BREASTED PLOVER, YELLOW LEGS, GOLDEN PLOVER | All | Oct. 15 to Jan. 31 | 15 per day, 30 per week |
| RAIL, WOOD DUCK, WILD PIGEON | All | No open season | |
| VALLEY AND DESERT QUAIL | All | Oct. 15 to Dec. 31 | 15 per day, 30 per week |
| MOUNTAIN QUAIL AND GROUSE | 1, 1½, 1¾, 4½, 23 | Sept. 1 to Nov. 30 | 10 mountain quail per day, 20 per week; 4 grouse per day, 8 per week |
| | Others | Oct. 15 to Dec. 31 | |
| SAGE HEN | All | Sept. 1 to Nov. 30 | 4 per day, 8 per week |
| DOVE | All | Sept. 1 to Nov. 30 | 15 per day |

tion. Plover and yellowlegs have been given complete protection for a number of years, and in 1941 Wilson snipe were placed on the protected list. There is now a brief open season on wild pigeons but rail and wood duck are still fully protected. Quail seasons and bag limits have been curtailed considerably and nowadays the same season and limit apply to all three species of quail. Grouse and sage hen are on the completely protected list at present and have been for some years. The dove season is now shorter and the bag limit is slightly lower. As an addition to our list of game birds we have the ring-necked pheasant, for which there is now a ten-day open season. The curtailments noted above have become necessary because of increasing scarcity of game and the larger numbers of hunters, and have been affected by State laws in the case of resident game, and by Federal and State action in the case of migratory game. It was possible to open the pigeon and pheasant seasons because of encouraging increases in these birds. The deer population has stood up well in the face of increased hunting pressure, so little restriction has been necessary.—*Richard S. Croker, Editor, California Fish and Game.*

## RETIREMENT OF H. B. NIDEVER

It is with regret that we announce the retirement of H. B. Nidever, Field Inspector of the Bureau of Marine Fisheries, California Division of Fish and Game, after 33 years of outstanding service.

Many changes have taken place in California's fisheries and in the Division since June 29, 1908, when Mr. Nidever first joined the

staff. He has witnessed the growth of the fishing industry from a local fishery based almost entirely on salmon and shellfish to the present-day industry which leads the Nation with its canned tuna, sardines and mackerel, its sole, barracuda, halibut and many others taken by a fleet of vessels fishing all along our coast and ranging far to the north and south of California. And, during this period the Division has kept pace with not only the commercial fisheries but with the rapidly increasing numbers of hunters and anglers, expanding from a handful of game wardens and fish hatcherymen to a force of several hundred engaged in all aspects of conservation work. Mr. Nidever has always been in the foreground during these years of progress with his far-seeing suggestions which he has many times followed through single-handed, and his ability and willingness to do the work of several men.

In his first years with the California Fish and Game Commission, Mr. Nidever was on the patrol force in the San Francisco Bay and Delta regions, as well as along the southern California coast. In those days the fishermen had no use at all for wardens and it took a rare combination of courage, forcefulness and tact to work with them. Although he sometimes had to use force, Mr. Nidever's greatest successes were due to his power of persuasion. He could talk the fisherman's language and was able to convert them to at least some of the principles of conservation. Even now he speaks of his labors as "missionary work," be it with the old-time gill netter and lobster fisherman or with the present-day sportsman and market operator.

In 1915 and the following years the Commission inaugurated the system for the collection and compilation of commercial fisheries statistics, which has since grown to include records on the game kill and sport fishermen's catches. Much of the initial planning and field work were done by Mr. Nidever, and his guiding spirit has aided the program ever since. It will be in this field that we will miss him most as he was the statistical system's strongest contact with the fishing industry. It will be difficult to replace him.

Not only will Mr. Nidever be missed by the tiny handful of pioneers who have worked with him since 1908 and who are still with us, but by the younger men who are beginning to think of themselves as old-timers and by the newcomers who have been guided and encouraged by the example he set and by the patient instruction he so cheerfully gave to all. We will miss "the skipper" but his contributions to our scientific, statistical and law enforcement programs will long be remembered and appreciated.—*Richard S. Croker, California Division of Fish and Game.*

## CANNED ROCKFISH

During May, 1941, one of the sardine canneries at Monterey, California, commenced canning several species of rockfish (Scorpaenidae), called rock cod by fishermen and marketmen. Although there are between 35 and 40 species of rockfish landed at that port, two species, bocaccio (*Sebastodes paucispinis*) and chili-pepper (*S. goodei*) make up about 70 per cent of the yearly landings, and these have been the ones canned in greatest quantity. However, some of the other large species which appear in lesser numbers, mainly yellowtailed

rockfish (*S. flavidus*) and two of the so-called red rock cod (*S. pinniger* and *S. miniatus*) have also been packed. Canning of Pacific cultus (*Ophiodon elongatus*) and sablefish (*Anoplopoma fimbria*) has also been tried experimentally along with the rockfish, but these two species do not offer the possibilities at Monterey that do the rockfish because they apparently are not as abundant.

The rockfish are packed in gallon cans and in No. 1 tall cans (15 ounces). Whole fillets are placed in the gallon cans and smaller broken pieces in the No. 1 cans. So far, the gallon size cans have been shipped to some of the State institutions and the No. 1 tall cans have been placed on the open market, labeled "rockfish (skinned, boneless, shredded)" and retailed at about 16 cents each. Approximately one-third of the original round weight of the rockfish remains after filleting and skinning and this is about the same ratio that the fresh fish markets obtain.

The cannery operating this year paid a wholesale fish market $50 a ton for the rockfish used in canning, or at the rate of two and one-half cents a pound. During the same period, the fishermen have been receiving three cents a pound for bocaccio, chili-pepper and yellow-tailed rockfish and four cents a pound for large red rock cod at the fresh fish markets. The slight discount granted by the wholesale fish market is recovered by the market through the livers which are retained when the fish are cleaned for the cannery. The canning company has been utilizing an occasional surplus not needed by the fresh fish markets and only a few tons of fish have been canned during this experimental venture. Future operations along this line will depend upon how well this preliminary pack is received by the public.—*J. B. Phillips, Bureau of Marine Fisheries, Division of Fish and Game, July, 1941.*

## SQUID CANNING AT MONTEREY, CALIFORNIA

The most important squid in California is the common market squid (*Loligo opalescens*), which attains a length of 12 inches and is found from Puget Sound to San Diego. Common squid are sold fresh, dried and canned. The dried and canned squid sales are primarily in the export market.

Almost the entire California squid catch is landed at the port of Monterey, where as early as 1888 the drying of squid for export to China was an important industry. However, no squid have been dried at Monterey or elsewhere in California since 1932. Cessation of this phase of the fishery was due to the instability of foreign exchange in China, as well as competition from a low-priced product from Japan.

Although fresh squid are sold in the domestic markets, the quantity absorbed through this channel is not great because these sales are mainly to people of a few nationalities who cultivated a taste for this cosmopolitan mollusk in the land of their birth. A great deal of the fresh squid is frozen for shipment to retail markets throughout California. During the spring of 1941, large quantities of fresh squid were also frozen in five-gallon liver cans and shipped as bait to shark fishermen working out of Santa Barbara and Port Hueneme, California.

Canning of squid in California is of minor importance. The average amount taken annually for canning during the period 1919-1940, inclusive, was approximately 50,000 pounds, and this includes two years when no squid were canned. During the last three years there has been a great increase in the amounts canned, reaching a peak of 935,000 pounds in 1940. Most of the recent pack has been produced by one Monterey cannery. Two or three other companies tried their hand at it in previous years but did not find the venture profitable enough to continue.

The bulk of the canned squid is exported. Previous to 1930, Greece took most of the product. However, the economic depression which occurred at that time placed it in the luxury class as far as the Greeks were concerned and the sales to that country became negligible. Since then a market in the Philippines has developed and that country

FIG. 86. Common squid (*Loligo opalescens*), known to the Italian fishermen of Monterey as "calamari". The length of this specimen is 11⅛ inches to the tips of the tentacular arms. Photo by J. B. Phillips, June, 1941.

now takes the majority of the export pack, with smaller amounts being shipped to Puerto Rico and Cuba.

Some sales of the canned product are made in the domestic market but competition is encountered in a similar pack from Portugal. The Portuguese product is in 4- and 5-ounce oval cans. One type of pack is the squid (cuttlefish, as it is sometimes called) in its own "ink," labeled "calameres en su tinta," and the other is "stuffed squid in olive oil." In this latter pack, the squid is cleaned. The Portuguese also sell canned octopus (devilfish) in this country in the same type of can, labeled "pulpo."

In California, squid have been put up in No. 1 tall cans (15 ounces) and also in 7-, 8- and 9-ounce tall and flat cans. The No. 1 tall can has not proved as popular as the smaller sizes. Aside from the natural pack, the Monterey cannery has tried adding different sauces to the canned product, mainly tomato sauce, olive oil, cottonseed oil and sesame oil. At present squid is canned natural style, that is, squid in its own ink, and squid in sesame oil with the ink absent.

The canning process is as follows: The fresh squid are thoroughly washed in salt water and placed in wire trays which are about two feet square and four inches deep. The filled trays are then run through a steam cooker, which is a long box open at both ends and provided with perforated pipes carrying live steam. The trays of squid are placed in one end of this box on an endless chain conveyor, requiring about 30 minutes to carry the trays through to the other end. During this precook the "ink" is steamed out of the squid. Upon emerging the squid are allowed to cool before being placed in cans. In the natural pack the whole squid is placed in the can and a small amount of the concentrated squid ink is introduced along with a little salt. The ink is the same as that cooked out during the initial cook but in a concentrated form. In the fancy pack containing sesame oil, the precooked squid are plucked of their eyes and horny beaks, and the chitinous pens are removed before the squid are placed in the can. Before sealing, the cans of both types of packs are subjected to an exhaust cook of 200° F. for 30 minutes. The ink or sesame oil is added to the cans after this cook preparatory to sealing. The sealed cans are then retorted for 90 minutes at 240° F. to conform to State health regulations. After this the cooled cans are washed, labeled and boxed. Cooked squid has a mild, shrimp-like flavor.

A season's pack of squid is ordinarily completed within a period of a few weeks during May or June when these mollusks are most abundant in Monterey Bay. During these months huge schools form in the south portion of the bay for spawning. Squid may be taken at other times of the year but they are not as readily available as during these two months. Catches are made primarily with lampara nets during the early daylight hours or at night. Although they can be taken with purse seines, the lampara is better suited to this type of fishing as it is important that not more than about 15 or 20 tons be taken in one haul. Too many squid should not be impounded at one time as they do not "herd" like fishes but flatten out against the meshes of the net, making the task of concentrating the catch laborious as well as exerting a great strain on the webbing. Nets are often ripped when too large a quantity is netted. Furthermore, as the capacity of the cannery is limited to about 25 tons a day, the small lamparas are adequate.—*J. B. Phillips, Bureau of Marine Fisheries, Division of Fish and Game, July, 1941.*

## OCCURRENCE OF THE TIGER SHARK IN CALIFORNIA

Twenty-five or more years ago rumor had it that the dreaded tiger shark could be found in the waters of southern California, but the only scrap of evidence was one reported capture at San Diego. Now, apparently for the first time, we have a definite record. On July 3, 1941, the boat "Lurane F.," operated by William Coleman, was fishing with set lines in 50 fathoms of water off Las Flores Canyon, north of Oceanside, San Diego County, when a large shark was hooked. When landed at Newport Beach, Orange County, it was examined by Wardens L. E. Lahr and T. W. Schilling, of the California Division of Fish and Game, who identified the fish as a tiger shark. It was a female, nine feet long and estimated to weigh 200 pounds.

The tiger shark (*Galeocerdo arcticus*) belongs to the family Galeidae, as do many of our common sharks such as the great blue, leopard, soupfin and smooth-hounds. It is world-wide in distribution in warm or temperate oceans. In 1917, E. C. Starks reported (California Fish and Game, vol. 3, p. 149) as follows: "This shark is not rare in tropical seas and is reported by fishermen as occurring along the southern California coast. It is only known from this region to zoologists, however, by some jaws of a specimen captured near San Diego."

During the years since then, it is possible that this fish may have been caught in this area but if so it was not reported. In the last few years, with the discovery of the valuable vitamins in liver oils, there has been a scramble for sharks and an awakened interest in any new or odd specimens of this group so we may find other rarities recorded from the coastal waters of the State.

The tiger shark has won an evil reputation in the tropics where it is claimed that there are instances of its having attacked men in the water. At any rate there are records of the contents of stomachs that have been opened and it appears that nearly everything but human flesh has served as food, even to land mammals such as sheep and cattle. It would seem that this fish with the "voracious habits" quite commonly preys upon other sharks judging by the frequency with which large chunks of shark meat, including skin, have occurred in the stomachs examined. It may be just as well that this fish is such a rarity in our waters.—*W. L. Scofield, Bureau of Marine Fisheries, Division of Fish and Game, July 18, 1941.*

## OCCURRENCE OF *ELOPS AFFINIS* IN THE COLORADO RIVER

Several months ago while below the Laguna Dam on the Colorado River, I was told of a seemingly new species of fish noticed jumping at times in the river. They were thought to be trout but as none had been caught their identity remained unknown.

On August 6, 1941, I visited this area and Mr. William Airs, keeper of the Laguna Dam, informed me that a fisherman had caught several. While there we were fortunate enough to obtain two specimens of this fish, one 11 inches long and the other 14. Mrs. Glidden caught these, one on shrimp bait and one on a piece of chicken entrails. They were unknown to us.

P. S. Barnhart of the Scripps Institution of Oceanography identified the fish as *Elops saurus* of the family Elopidae, a fish closely related to the tarpon. Pacific coast specimens of *Elops* are now considered as distinct from the Atlantic *saurus*, and are known as *E. affinis*. This fish, which attains a length of three feet, abounds in the Gulf of California but so far as we can learn this is the first record of its occurrence in the Colorado River. Inasmuch as the tarpon ascends fresh-water rivers it is perhaps not surprising to find *Elops* so far from salt water. However, there has been considerable scientific collecting and a large amount of angling in the river so that if this fish were a regular resident it would surely have been reported before now.

*Elops* is a game fish of some note on the Atlantic coast, but is not well known along the Pacific coast of Mexico. It will take a spoon or

cut bait and fights spectacularly, making many leaps. Those we took fought well for their size. It is to be hoped that this fish will establish itself in the river and find its way into Salton Sea where it would be a very desirable game fish. Perhaps the greatest objection to it is the long list of common names by which it is known, most of which are unsatisfactory: ten-pounder, big-eyed herring, big-sized herring, large-mouth herring, John Mariggle, bonyfish, bonefish, matajuelo real, lisa francesca and awa.—*E. H. Glidden, Bureau of Patrol, California Division of Fish and Game, August, 1941.*

# Reviews

## Wildlife Conservation

By Ira N. Gabrielson. New York, Macmillan Company, 1941. 250 pp., 32 pls., 24 figs.

*Wildlife Conservation* is a definite contribution to the literature on the administration of wildlife resources. With his long experience in field and administrative work with American game, Gabrielson is well fitted to write on the subject. The book is not overly long, it is general rather than minutely specific, and it is well written.

All aspects of wildlife resources are covered, with much stress being laid on the interrelation of all living things and their dependence on soil and water. The author points out that wise management of any one kind of animal depends largely on equally wise management of many other kinds of animals as well as sensible use of our water, soil and plant resources. He advocates not only limiting the annual harvest to something less than the yearly natural increase of a species, but also the restoration of adequate environment—particularly food and cover. Reductions in the numbers of our game animals have come about because of overhunting and destruction or impairment of habitat from unwise use of water, soil, forests and grasslands. Throughout the book a feeling of optimism prevails rather than the usual crying over spilt milk.

The book contains chapters on soil erosion, water conservation, forest conservation and grassland conservation. Resident game, migratory birds, fur animals, nongame birds and mammals, aquatic life, and rare and vanishing species are all treated separately. There is also a thought-provoking chapter on predatory animals. Wildlife refuges come in for their share of discussion, as Gabrielson believes they offer one of our best hopes for the restoration of our birds and mammals.

The obstacles to conservation are listed: The shortsightedness of administrators and the public; the old American custom of trying panaceas instead of seeking a solution; and the lack of understanding among administrators, sportsmen and the general public. Remedies recommended are: An intelligent, alert conservation group in every community; conservation education in the schools; persistency in the conservation movement with no relaxation when slight gains are made; more and more research; a continuous program of soil and water conservation; and environmental restoration. The last two paragraphs are worth repeating over and over:

"Environmental restoration (the putting of nature's forces to work for men) and limitation of the harvest to the crop produced have proved successful in increasing stocks of game and fishes. The trend is distinctly upward where these methods have been faithfully adhered to. The scope of rational management should be greater, and as the program continues the effect of increasing natural production will be cumulative. The most uncertain factor is not management itself but

public support for a suitable and effective program that may be neither a spectacular performance nor a crusade. Each square mile of territory improved for wildlife will go on producing annual crops while other lands are being improved; each stream cleared of pollution will make its annual contribution of fishes while other waters are being restored. The conservation battle can not be a short, sharp engagement, but must be grim, tenacious warfare—the sort that makes single gains and then consolidates these gains until renewed strength and a good opportunity make another advance possible.

"It is yet to be demonstrated whether the conservation forces of America or the American people can wage that kind of fight. Much of our vaunted success in 'conquering a continent in record time' has been in reality appalling wastefulness. Now America faces the hard task of putting to work natural forces in restoration and of staying tirelessly on the job throughout future years."

Being a Federal man, Gabrielson views the conservation problem from a nation-wide angle and tends to minimize the work done by State conservation agencies. There is much to be said for this viewpoint, as many wildlife problems are nation-wide or even international in scope, and also many local agencies have not done as much as they should have. However, more credit should have been given to the numerous State conservation departments which have shown so much improvement lately and which are actually doing better work under a more enlightened program in areas under their jurisdiction—and in cooperative programs with other States—than some Federal agencies.

*Wildlife Conservation* is heartily recommended to all who are beginning careers in conservation work, and those administrators and research men already engaged in wildlife restoration will find it equally useful and thought-provoking. We should all read it once a year as a "refresher."—*Richard S. Croker, Editor, California Fish and Game.*

**Marine Food and Game Fishes of California**

By L. Ernest Herz. Science Guide for Elementary Schools, vol. 6, no. 3, 89 pp., 74 figs. Sacramento, California State Department of Education, 1941.

This booklet is the most recent to appear in the long and useful series of school science guides produced by the staffs of California state colleges. It is concerned principally with descriptions of the most important commercial and game fishes and their fisheries. The author is a former staff member of the California Division of Fish and Game and draws heavily on the publications of the Division for his illustrations and descriptive material.

With this guide, California school teachers should be able to impart some idea of the importance of our fisheries resources to their pupils.—*Richard S. Croker, Editor, California Fish and Game.*

**Studies of the Striped Bass *(Roccus saxatilis)* of the Atlantic Coast**

By Daniel Merriman. U. S. Fish and Wildlife Service. Fishery Bulletin, no. 35 (vol. 50), 77 pp., 36 figs., 23 tables, 1941.

In view of the great interest in striped bass by fishermen of the Atlantic and Pacific coasts, Merriman's paper is timely. This well

written and comprehensive report embodies research carried on for several years all along the Atlantic coast but particularly in Connecticut.

The striped bass is much less abundant now than formerly along the Atlantic because of the pollution of spawning streams and overfishing. However, a temporary abundance occurred recently due to a particularly successful spawning and survival in 1934.

Merriman found that female bass mature at an age of three years, males at two. Tag returns indicate a striking migration to the north in the spring and south in the fall, principally by immature female fish. Spawning takes place in the spring to the south, mainly in the neighborhood of Chesapeake and Delaware bays.

Striped bass are universal in their choice of food, a wide variety of fish and crustaceans forming the main diet.

The author recommends a minimum size limit of 16 inches to protect the fish until they are three years old. This would not only provide more spawners for the present spawning grounds but might make possible the rehabilitation of former spawning rivers to the north. —*Richard S. Croker, Editor, California Fish and Game.*

# IN MEMORIAM

## HARRISON A. LAWS

On May 29, 1941, Harrison A. Laws, fish hatchery man in charge of Alpine Hatchery and Heenan Lake Egg Collecting Station, died from exposure, following the upsetting of a boat in which he and Assistant Fish and Game Warden Charles Kanig were crossing Heenan Lake, Alpine County. Harrison A. Laws came to work with the Division in April, 1931, having had previous fish-cultural experience in Idaho. He was promoted to Fish Hatchery Man in March, 1941, and placed in charge of the Alpine Hatchery in April.

He was one of the best liked and more promising of our younger men and enjoyed that happy faculty of making lasting friends of every one he met. Harry, as he was known to his many friends, was one of the few remaining typically western characters among the younger personnel of the Bureau of Fish Conservation, and his pleasing personality together with his characteristic hospitality is something long to be remembered.

He leaves his mother, Mrs. Lola G. Laws and a sister residing in Hollister, and a brother in the Government service at Wake Island. To them we extend our sincere sympathies.—*A. E. Burghduff, California Division of Fish and Game.*

## BYRON SYLVESTER

It is our painful duty to record the death of Byron Sylvester in the crash of an Army airplane on July 24, 1941.

Byron Sylvester entered the service of the California Division of Fish and Game in May, 1938, as an Assistant Fish and Game Warden. From the beginning his work was characterized by both a youthful enthusiasm for the task at hand and a firm resolve to get ahead. During the three years that he was with us he had an opportunity to become experienced in all of the various phases of our work. Byron studied hard and was looking forward to his first promotion.

He was born in Muskogee, Oklahoma, on July 26, 1917. His family later moved to San Francisco where he graduated from Polytechnic High School. From 1935 to 1938 he attended the University of California at Davis. He had just graduated from the nondegree course there when he was offered an appointment as Assistant Warden. He was a fine athlete, excelling in a wide variety of outdoor sports. During his college years he was a member and finally captain of the California Aggie ski team.

In March, 1941, Byron requested a leave of absence so that he might enlist in the United States Army Air Corps. He had already

earned his pilot's license in his spare time while on duty at the Almanor Hatchery and on patrol work near Susanville.

He had completed his preliminary training at the Cal Aero Training School at Oxnard and was undergoing basic training at Camp Wasco in Kern County when he met with the accident that cost his life. While making a forced landing near Bakersfield on July 24, the tail of the plane he was piloting struck a high tension line. Cadet Sylvester and the officer who was with him in the plane were instantly killed when the plane crashed.

The Fish and Game Commission and the employees of the Division of Fish and Game extend their sincere sympathies to the members of his family.—*Gordon H. True, Jr., California Division of Fish and Game.*

## I. ZELLERBACH

I. Zellerbach, former President of the California Fish and Game Commission, died in the Mills Memorial Hospital in San Mateo, August 7, 1941.

Mr. Zellerbach was appointed Fish and Game Commissioner on May 5, 1925, by Governor Richardson and held office through successive administrations for nearly 14 years, when his resignation was accepted on January 1, 1939. During most of these years he was President of the Board of Commissioners. The length of his service speaks well for the esteem and respect in which he was held by the several Governors of California under whom he served.

The I. Zellerbach whom I had the privilege of knowing was kindly, sympathetic and understanding. A visit to his busy office—his door was always open to us of the Division of Fish and Game—was a pleasure, his council restful. You left him eased in mind and with the knowledge that you had with you a man in whom you could place your trust and confidence.

I, personally, lost one of my best friends, as did all the employees of this Division, in his passing.—*J. S. Hunter, California Division of Fish and Game.*

# REPORTS

## STATEMENT OF REVENUE

**For the Period July 1, 1940, to June 30, 1941, of the Ninety-second Fiscal Year**

| Revenue for Fish and Game Preservation Fund: | Detail | Total |
|---|---|---|
| License Revenue: | | |
| 1941 series— | | |
| Angling | $338,347 00 | |
| Hunting | 119 00 | |
| Deer tags | 13 00 | |
| Fish tags | 2,018 43 | |
| Game tags | 100 13 | |
| Market fishermen | 40,230 00 | |
| Fish importers | 80 00 | |
| Fishing party boat permits | 414 00 | |
| Fish breeders | 435 00 | |
| Game breeders | 1,292 50 | |
| Game management | 3 66 | |
| Kelp license | 20 00 | |
| Total 1941 series | | $383,072 72 |
| 1940 series— | | |
| Angling | $499,681 00 | |
| Hunting | 556,744 00 | |
| Commercial hunting club | 875 00 | |
| Commercial hunting club operator | 305 00 | |
| Trapping | 1,955 00 | |
| Fish packers and wholesale shellfish dealers | 990 00 | |
| Deer tags | 162,880 00 | |
| Fish tags | 1,904 00 | |
| Game management | 170 00 | |
| Game management tags | 146 35 | |
| Game tags | 429 99 | |
| Market fishermen | 44,320 00 | |
| Fishing party boat permits | 177 00 | |
| Fish breeders | 50 00 | |
| Game breeders | 137 50 | |
| Kelp license | 20 00 | |
| Total 1940 series | | $1,270,784 84 |
| 1939 series— | | |
| Angling | $4,767 50 | |
| Hunting | 9,201 00 | |
| Trapping | 79 00 | |
| Deer tags | 1,324 00 | |
| Market fishermen | 200 00 | |
| Total 1939 series | | $15,571 50 |
| Total licenses, 92d fiscal year | | $1,669,429 06 |
| Other revenue— | | |
| Court fines | $43,542 37 | |
| Deer meat permits | 3,151 00 | |
| Fish packers tax | 304,013 07 | |
| Kelp tax | 546 04 | |
| Lease of kelp beds | 1,334 50 | |
| Miscellaneous | 6,076 13 | |
| Publication sales | 410 22 | |
| Salmon packers tax | 32,893 51 | |
| Total other revenue | | $391,966 84 |
| Grand total revenue all years, Fish and Game Preservation Fund | | $2,061,395 90 |

## STATEMENT OF EXPENDITURES

**For the Period July 1, 1940, to June 30, 1941, of the Ninety-second Fiscal Year**

| Function | Salaries and wages | Materials and supplies | Service and expense | Property and equipment | Total |
|---|---|---|---|---|---|
| Administration: | | | | | |
| Demolition of exposition exhibits | $126 00 | $1,215 41 | $3,440 99 | | $4,782 40 |
| Education and public information | 395 16 | 48 20 | 261 20 | $263 68 | 968 24 |
| Executive | 1,922 01 | 270 01 | 5,338 72 | 3 97 | 7,534 71 |
| Exhibits | | | 1,323 07 | | 1,323 07 |
| Fish and game magazine | | 3,087 53 | | | 3,087 53 |
| General office | 8,825 96 | 2,960 52 | 76,037 36 | 602 96 | 88,426 80 |
| Library | 2,130 00 | 66 85 | 147 39 | 210 70 | 2,554 94 |
| Property inspection | 2,093 41 | 47 66 | 159 89 | | 2,300 96 |
| Total Administration | $15,492 54 | $7,696 18 | $86,708 62 | $1,081 31 | $110,978 65 |
| Patrol and Law Enforcement: | | | | | |
| Cannery inspection | $22,982 83 | $454 15 | $2,506 89 | | $25,943 87 |
| Executive | 17,231 68 | 465 88 | 2,047 01 | $21 63 | 19,766 20 |
| General office | 6,750 00 | 708 12 | 1,192 59 | 262 18 | 8,912 89 |
| Junior patrol | 3,530 00 | 360 58 | 642 13 | 1,012 28 | 5,544 99 |
| Land patrol | 254,150 74 | 38,149 25 | 66,253 82 | 31,321 05 | 389,874 86 |
| Marine patrol | 91,997 33 | 22,602 96 | 48,912 50 | 27,219 28 | 190,732 07 |
| M. V. *Bluefin* galley | | —366 50 | 15 30 | | —351 20 |
| M. V.–*N. B. Scofield* galley | | —1,009 24 | 304 86 | | —704 38 |
| Pollution patrol | 13,935 54 | 2,585 08 | 5,082 53 | 1,135 60 | 22,738 75 |
| Total Patrol and Law Enforcement | $410,578 12 | $63,950 28 | $126,957 63 | $60,972 02 | $662,458 05 |
| Marine Fisheries: | | | | | |
| Central Valley water project study | $6,129 50 | $1,025 45 | $1,660 47 | $153 72 | $8,969 14 |
| Executive | 4,940 00 | 68 32 | 462 44 | 1 88 | 5,472 64 |
| Field supervision | 3,660 00 | 253 84 | 897 38 | | 4,811 22 |
| Fish cannery auditing | | | 3,821 69 | | 3,821 69 |
| General office | 11,736 90 | 585 33 | 399 86 | 450 74 | 13,172 83 |
| Research and statistics | 60,833 10 | 8,354 85 | 10,602 77 | 2,852 58 | 82,643 30 |
| Total Marine Fisheries | $87,299 50 | $10,287 79 | $17,844 61 | $3,458 92 | $118,890 82 |
| Fish Conservation: | | | | | |
| Biological survey | $11,365 00 | $1,993 72 | $1,363 01 | $667 21 | $15,388 94 |
| Executive | 9,143 01 | 216 86 | 1,300 27 | 621 74 | 11,281 88 |
| Field supervision | 4,664 20 | 503 28 | 858 68 | 389 03 | 6,415 19 |
| Fish food unallocated | | 12,112 83 | 4,382 16 | | 16,494 99 |
| Fish planting | 3,135 06 | 2,022 80 | 1,519 69 | 1,600 90 | 8,278 45 |
| Fish rescue | 11,669 29 | 1,327 83 | 2,565 23 | 506 14 | 16,068 49 |
| General office | 7,265 00 | 1,162 09 | 997 36 | 552 43 | 9,976 88 |
| Pollution inspection | 4,940 66 | 456 66 | 882 98 | 1,457 11 | 7,737 41 |
| Statistical | 2,476 46 | 401 78 | 1,221 32 | 154 50 | 4,254 06 |
| Stream improvements | | | 1 68 | | 1 68 |
| Structural maintenance | 2,728 55 | 360 60 | 987 13 | | 4,076 28 |
| Alpine Hatchery | 2,465 98 | 1,164 22 | 254 57 | 27 78 | 3,912 55 |
| Arrowhead Lake Egg Collecting Station | 7,607 09 | 2,503 34 | 1,404 90 | 1,665 03 | 13,180 36 |
| Basin Creek Hatchery | 5,722 25 | 1,373 75 | 536 81 | 8 59 | 7,641 40 |
| Bear Lake Egg Collecting Station | 517 42 | 12 00 | | | 529 42 |
| Benbow Dam Experimental Station | 1,913 87 | 113 11 | 96 93 | | 2,123 91 |
| Big Creek Hatchery | | 27 29 | —35 | | 26 94 |
| Blue Lakes Egg Collecting Station | | 30 76 | | | 30 76 |
| Bogus Creek Egg Collecting Station | 823 28 | 86 56 | 184 94 | 7 90 | 1,102 68 |
| Brookdale Hatchery | 6,062 20 | 2,151 96 | 844 48 | 42 27 | 9,100 91 |
| Burney Creek Hatchery | 7,394 18 | 1,510 11 | 426 98 | 14 50 | 9,345 77 |
| Central Valleys Hatchery | 2,966 78 | 740 33 | 1,707 41 | 255 82 | 5,670 34 |
| Copco Egg Collecting Station | 559 35 | 74 18 | 88 84 | | 722 37 |
| Cottonwood Lakes Egg Collecting Station | 250 00 | | | | 250 00 |
| Experimental Hatchery | 1,130 00 | 7 21 | 30 25 | | 1,167 46 |
| Fall Creek Hatchery | 6,853 34 | 1,368 55 | 226 87 | 656 22 | 9,104 98 |
| Feather River Hatchery | 5,340 00 | 1,454 14 | 492 83 | 97 89 | 7,384 86 |
| Fern Creek Hatchery | 1,903 57 | 2,459 15 | 860 12 | | 5,222 84 |
| Fillmore Experimental Station | 2,946 56 | 877 40 | 927 55 | 714 61 | 5,466 12 |

## STATEMENT OF EXPENDITURES—Continued

**For the Period July 1, 1940, to June 30, 1941, of the Ninety-second Fiscal Year**

| Function | Salaries and wages | Materials and supplies | Service and expense | Property and equipment | Total |
|---|---|---|---|---|---|
| Fish Conservation—Continued: | | | | | |
| Fishing Creek | | | $150 00 | | $150 00 |
| Forest Home Hatchery | $2,254 52 | $1,596 35 | 771 09 | | 4,621 96 |
| Fort Seward Hatchery | 4,330 14 | 889 20 | 216 61 | $40 40 | 5,476 35 |
| Heenan Lake Egg Collecting Station | | 85 17 | | 5 05 | 90 22 |
| Hot Creek Hatchery | 6,947 63 | 9,429 08 | 1,552 91 | 32 44 | 17,962 06 |
| Huntington Lake Hatchery | 880 32 | 164 51 | 244 34 | 85 80 | 1,374 97 |
| June Lake Egg Collecting Station | 320 00 | | | | 320 00 |
| Kaweah Hatchery | 5,577 48 | 1,228 50 | 983 83 | 95 62 | 7,885 43 |
| Kern Hatchery | 2,032 33 | 274 09 | 381 17 | 1,066 24 | 3,753 83 |
| King Salmon Experimental Station | | 18 58 | 31 04 | | 49 62 |
| Kings River Hatchery | 7,034 85 | 2,039 18 | 658 87 | 14 05 | 9,746 95 |
| Kirman Lake Egg Collecting Station | 393 04 | 33 10 | 74 01 | | 500 15 |
| Klamathon Egg Collecting Station | 1,068 78 | 177 48 | 70 41 | | 1,316 67 |
| Lake Almanor Hatchery | 7,397 53 | 3,363 55 | 960 92 | 279 72 | 12,001 72 |
| Lake Eleanor Egg Collecting Station | 222 25 | 33 07 | | 5 34 | 260 66 |
| Little River Egg Collecting Station | 343 23 | 8 05 | | | 351 28 |
| Little Walker Lake Egg Collecting Station | 255 00 | | | | 255 00 |
| Mad River Egg Collecting Station | 600 00 | 105 59 | | 8 38 | 713 97 |
| Madera Hatchery | 1,998 80 | 604 07 | 471 03 | 46 43 | 3,120 33 |
| Mt. Shasta Hatchery | 45,434 46 | 21,937 62 | 2,709 61 | 3,106 18 | 73,187 87 |
| Mt. Tallac Hatchery | 3,276 59 | 2,079 93 | 269 60 | 14 49 | 5,640 61 |
| Mt. Whitney Hatchery | 15,487 36 | 2,907 19 | 2,029 83 | 1,118 83 | 21,543 21 |
| Prairie Creek Hatchery | 6,122 67 | 1,263 85 | 863 83 | 14 81 | 8,265 16 |
| Rearing Reservoir | 2,624 13 | 2,785 15 | 1,105 93 | 231 64 | 6,746 85 |
| Rush Creek Egg Collecting Station | 347 81 | | | | 347 81 |
| San Lorenzo Egg Collecting Station | | 137 52 | 37 09 | | 174 61 |
| Scott Creek Egg Collecting Station | 1,530 00 | 30 52 | 113 39 | 485 28 | 2,159 19 |
| Sequoia Experimental Station | 1,029 02 | 376 85 | 561 19 | 743 54 | 2,710 60 |
| Shackleford Creek Egg Collecting Station | | | 50 00 | | 50 00 |
| Shasta River Egg Collecting Station | 937 33 | 28 48 | 117 50 | 7 15 | 1,090 46 |
| Snow Mountain Egg Collecting Station | 2,455 25 | 304 69 | 147 89 | 2 13 | 2,909 96 |
| Tahoe Hatchery | 8,668 30 | 2,088 45 | 878 44 | | 11,635 19 |
| Upper Truckee Egg Collecting Station | 153 33 | | 34 00 | | 187 33 |
| Waddell Creek Station | 1,770 00 | 128 90 | 101 44 | | 2,000 34 |
| Yosemite Hatchery | 5,499 35 | 1,437 64 | 571 14 | 26 87 | 7,535 00 |
| Yuba River Hatchery | 3,970 00 | 570 79 | 168 83 | | 4,709 62 |
| Total Fish Conservation | $252,804 60 | $92,639 66 | $40,488 58 | $16,870 06 | $402,802 90 |
| Engineering: | | | | | |
| Engineering | $11,993 61 | $1,216 61 | $3,383 45 | $2,800 80 | $19,394 47 |
| Executive | 4,560 00 | 379 54 | 1,050 64 | | 5,990 18 |
| Fish screens | 1,369 20 | 483 13 | 183 98 | | 2,036 31 |
| General office | 1,646 00 | 40 62 | 126 10 | 60 83 | 1,873 55 |
| Total Engineering | $19,568 81 | $2,119 90 | $4,744 17 | $2,861 63 | $29,294 51 |
| Game Conservation: | | | | | |
| Duck rescue | 1,250 00 | 305 44 | 833 75 | 3 72 | 2,392 91 |
| Elk refuge | 1,928 67 | 319 81 | 419 53 | | 2,668 01 |
| Executive | 9,720 00 | 706 18 | 1,986 98 | 750 19 | 13,163 35 |
| Game management | 11,266 71 | 1,944 96 | 2,845 62 | 872 71 | 16,930 00 |
| General office | 3,627 32 | 66 79 | 1,090 40 | 253 16 | 5,037 67 |
| Grey Lodge Refuge | 5,030 00 | 790 75 | 148 56 | 629 55 | 6,598 86 |
| Imperial Refuge | 2,976 13 | 253 87 | 236 65 | | 3,466 65 |
| Los Banos Refuge | 4,407 35 | 653 30 | 566 78 | 1,684 52 | 7,311 95 |
| Predatory animal—lion hunting | 6,684 01 | 935 66 | 7,724 43 | 1,376 60 | 16,720 70 |
| Predatory animal trapping | 33,778 78 | 7,667 23 | 6,726 41 | 4,637 26 | 52,809 68 |
| Refuge posting | | 859 85 | | | 859 85 |
| Research | 7,676 54 | 1,138 84 | 2,240 22 | 123 70 | 11,179 30 |
| Statistics | 1,956 70 | 482 35 | 1,109 67 | | 3,548 72 |
| Suisun Refuge | 3,797 12 | 567 62 | 427 05 | 306 52 | 5,098 31 |
| Winter feeding and salting of game | | 209 35 | | | 209 35 |
| Total Game Conservation | $94,099 33 | $16,902 00 | $26,356 05 | $10,637 93 | $147,995 31 |

## STATEMENT OF EXPENDITURES—Continued

**For the Period July 1, 1940, to June 30, 1941, of the Ninety-second Fiscal Year**

| Function | Salaries and wages | Materials and supplies | Service and expense | Property and equipment | Total |
|---|---|---|---|---|---|
| Game Farms: | | | | | |
| Executive | $3,840 00 | $87 40 | $658 53 | $601 00 | $5,186 93 |
| Game bird distribution— | | | | | |
| Los Serranos | 2,229 67 | 906 38 | 1,116 73 | | 4,252 78 |
| Yountville | 10,736 77 | 2,312 90 | 2,559 09 | | 15,608 76 |
| Game management | 1,480 00 | 311 30 | 252 95 | 519 41 | 2,563 66 |
| General office | 1,121 93 | 6 93 | 7 85 | | 1,136 71 |
| Los Serranos boarding house | | | 31 78 | | 31 78 |
| Los Serranos game farm | 11,339 40 | 4,060 13 | 1,641 13 | 10 75 | 17,051 41 |
| Yountville boarding house | 918 98 | 1,016 91 | 141 38 | | 2,077 27 |
| Yountville Game Farm | 14,988 66 | 7,367 15 | 1,604 61 | 1,747 27 | 25,707 69 |
| Total Game Farms | $46,655 41 | $16,069 10 | $8,014 05 | $2,878 43 | $73,616 99 |
| Licenses: | | | | | |
| Executive | $3,840 00 | $140 62 | $191 00 | | $4,171 62 |
| General office | 1,642 25 | 829 00 | 1,167 85 | $276 35 | 3,915 45 |
| License distribution | 14,199 94 | 18,896 53 | 74,765 36 | 209 56 | 108,071 39 |
| Total Licenses | $19,682 19 | $19,866 15 | $76,124 21 | $485 91 | $116,158 46 |
| Grand total, excluding special support items | | | | | $1,662,195 69 |

## FISH CASES

**April, May, June, 1941**

| Offense | Number arrests | Fines imposed | Jail sentences (days) |
|---|---|---|---|
| Abalones: No license, undersized, closed season, red undersized | 59 | $1,215 50 | |
| Angling: No license, alien using citizen license, overlimit, closed season, closed stream, with set line | 136 | 1,781 50 | 49½ |
| Barracuda: No license, overlimit | 13 | 270 00 | 4 |
| Bass: Black, closed season, overlimit, at night, striped, with two rods, angling with two lures, taking kelp bass, no license | 109 | 1,848 50 | 119½ |
| Catfish: Overlimit, closed season in District 4, no license | 13 | 355 00 | |
| Clams: Overlimit of Washington, Pismo, no license, overlimit razor clams, undersized Pismo clams, fail keep record of clams bought from diggers, cockle clams, no license, overlimit | 64 | 1,147 50 | 27½ |
| Commercial fishing: No license | 21 | 190 00 | 50 |
| Crabs: Possession undersized | 5 | 175 00 | |
| Crappie: Closed season, selling | 12 | 250 00 | |
| Dip net: Take fish with baited dip net | 1 | 25 00 | |
| Fail show fish upon demand | 2 | 35 00 | |
| Fish within 150 feet of lower side of dam, too near a fish screen | 13 | 215 00 | |
| Fishway: Fish in upper end | 1 | | |
| Frogs: Possession overlimit | 2 | 25 00 | |
| Fyke nets: Meshes less than 2½ inches | 2 | | |
| Gill net: Closed district, use in District 21 for taking yellowfin croaker | 5 | 100 00 | |
| Night fishing | 2 | 50 00 | |
| Operate net to take fish | 3 | 5 00 | |
| Operate party boat, no permit | 1 | | |
| Perch: Overlimit, closed season | 7 | 122 50 | 12½ |
| Pollution | 23 | 5,050 00 | |
| Salmon: Closed season, undersized | 3 | 45 00 | |
| Set line in District 11 | 10 | 190 00 | 50 |
| Sunfish: Closed season, no license, green, no license | 45 | 579 00 | 85 |
| Trammel net in District 12 | 2 | | |
| Trolling with two lures on one line | 2 | 25 00 | |
| Trout: Clubbing, closed season, no license, take with snag hook, closed district | 61 | 1,170 00 | 10 |
| Tuna: Using purse seine net to take bluefin tuna | 2 | 900 00 | |
| Yellowtail: Possess on boat carrying round haul net | 1 | 25 00 | |
| Totals | 620 | $15,794 50 | 408 |

## GAME CASES

**April, May, June, 1941**

| Offense | Number arrests | Fines imposed | Jail sentences (days) |
|---|---|---|---|
| Bear: Possession of illegally taken bear | 2 | | |
| Deer: Possession parts of female closed season | 10 | $200 00 | 227½ |
| Deer meat: Closed season | 29 | 1,275 00 | 405 |
| Doves: Closed season, no license | 12 | 190 00 | 101 |
| Ducks: Closed season | 4 | 40 00 | |
| Firearms in refuge | 11 | 225 00 | 12½ |
| Hunting: No license, fail to show license on demand, night hunting | 17 | 181 00 | 91 |
| Mudhens: Closed season | 2 | 10 00 | |
| Non-game birds | 1 | 15 00 | |
| Quail: Closed season | 3 | 98 00 | 1 |
| Pheasants: Closed season | 25 | 610 00 | |
| Pigeons: Closed season | 4 | 60 00 | 90 |
| Rabbits: Cottontails, no license, closed season, jack rabbits, no license | 22 | 175 00 | |
| Shoot from auto: late | 5 | 90 00 | |
| Shorebirds | 2 | 25 00 | 5 |
| Silencer: Possess and operate for taking wild game | 1 | 300 00 | |
| Squirrels: Possess tree squirrel | 1 | 50 00 | |
| Totals | 151 | $3,544 00 | 933 |

## SEIZURES OF FISH AND GAME

### April, May, June, 1941

| | |
|---|---|
| **Fish:** | |
| Abalones | 71 |
| Abalones, red | 131 |
| Barracuda, pounds | 5,483 |
| Bass | 4 |
| Bass, pounds | 2 |
| Bass, black | 18 |
| Bass, black, pounds | 10 |
| Bass, calico | 9 |
| Bass, striped | 84 |
| Bass, striped, pounds | 3 |
| Bass, white sea, pounds | 1,285 |
| Carp, pounds | 27 |
| Catfish | 1 |
| Catfish, pounds | 5 |
| Clams, Pismo | 623 |
| Clams, Washington | 30 |
| Cockles | 5,712 |
| Cockles, pounds | 125 |
| Crabs | 22 |
| Crappie | 60 |
| Crappie, pounds | 5 |
| Frog legs, pounds | 16 |
| Fyke net | 4 |
| Perch | 91 |
| Sunfish | 82 |
| Sunfish, bluegill | 194 |
| Sunfish, bluegill, pounds | 2 |
| Sunfish, green | 66 |
| Trout | 115 |
| Trout, eastern brook | 8 |
| Trout, Loch Leven | 7 |
| Trout, rainbow | 162 |
| Trout, rainbow, pounds | 24 |
| Trout, steelhead | 128 |
| Yellowtail, pounds | 6,803 |
| **Game:** | |
| Avocet | 1 |
| Deer | 4 |
| Deer meat, pounds | 429 |
| Doves | 7 |
| Ducks, mallards | 4 |
| Ducks, scoters | 5 |
| Mudhens | 1 |
| Phalaropes | 6 |
| Pheasants | 11 |
| Pigeons | 4 |
| Quail, valley | 1 |
| Rabbits, brush | 3 |
| Rabbits, cottontail | 21 |
| Stilts | 2 |
| Squirrels, tree | 1 |

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